MAKERERE UNIVERSITY

COLLEGE OF ENGINEERING, DESIGN, ART AND TECHNOLOGY

DEPARTMENT OF CIVIL AND ENVIRONMENTAL ENGINEERING

REVISED PROGRAMME OF MASTER OF SCIENCE IN CIVIL ENGINEERING (MSc CE)

DAY/ EVENING PROGRAMME

March 2011

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Master of Science in Civil Engineering

1 Background to the Programme

The Master of Science and Master of Engineering in Civil Engineering programme has been in existence for over 13years and graduated at least 80 students. However, during the existence of the two programmes, a lot has changed within the different subjects of the civil engineering profession. The distinct subject fields with clear career prospects in Uganda are Structural Engineering, Highway/Transportation Engineering, Water Resources Engineering, Environmental Engineering and Geotechnical Engineering. The original programme offered students an opportunity to undertake courses in any of these specialized subject fields under the Master Engineering or Master of Science programme. However the programme has been reviewed and revised to offer these specialized courses under a single programme, Master of Science in Civil Engineering (MSc CE) but with two plans so as to be in line with the profession requirements here in Uganda and in the world over; and also in consideration of today's best practice in Makerere and other universities.

The programme aims at balancing the interdisciplinary nature of the field with current and future needs, thus ensuring the employment of its graduates, while creating students with technical competence, communication skills and global awareness to assume a leadership role in civil engineering. Hence the programme seeks to satisfy the demands for both the employer and students.

The **objectives** of the programme are to: -

1. Enable postgraduate students undergo a programme of upgrading and updating their technical knowledge in a specialized field of civil engineering
2. Introduce the student to applied research relevant to industrial needs of the country
3. Produce post graduates with a qualification sufficient to meet the needs of staff development of local universities and technical colleges.

2 Research and Development

To make learning more research and development oriented in the curriculum, it is necessary to deliver every course (depending on course type) both core and elective with either a strong research or development bias. In other words, the mode of delivery of respective courses should emphasize on students spending more time researching (including reporting/presenting their work/results) and development rather than keeping in class. This is to enable students to learn how to conduct research as well as to learn the various research methodologies. In the curriculum, the

courses in each of the areas of specialization accommodate the two components i.e. research and development. The courses offered for research development are therefore compulsory (core) courses.

3 The Programme

3.1 Target group

For the foreseeable future, it is anticipated that MSc CE program will continue to attract students who are holders of BSc. Degree in Civil Engineering of an Upper Second class of Makerere University or its equivalent from a recognized University. Candidates with a lower second class degree may also be considered if they provide sufficient evidence that they have been in full time employment following the discipline of Civil Engineering or its equivalent for at least two years or sufficient evidence that they have experienced academic growth since graduation, as may be determined by the School of Engineering. In traditional graduate programs, it is assumed that entering students have a common background obtained through an undergraduate degree in that field. Specifically, the MSc. CE program is appropriate for:

- New graduates with degrees in Civil Engineering
- Experienced Civil Engineering professionals seeking to upgrade skills and to understand management issues
- Post graduate diploma holders in Civil Engineering who wish to upgrade to Masters level

3.2 Admission Requirements

To qualify for admission, a candidate must fulfill the general Makerere University entry requirements for a master's degree, and in addition a candidate must be a holder of either:

a. A BSc. Degree in Civil Engineering of at least an Upper second class or its equivalent awarded by Makerere University or any other recognized institution; **Or**
b. A BSc. Degree in Civil Engineering of a lower second class degree or its equivalent from a recognized institution with evidence of academic growth and maturity in this field of study as judged by the Board of Graduate Studies and Research; **Or**
c. Any other degree with sufficient evidence that they have been in full time employment following the discipline of Civil Engineering or its equivalent for at least two years.

3.3 Nature of the Programme

This is a day / evening programme that is completely privately sponsored and its duration is two years. Students on the Masters of Science in Civil Engineering Degree Program shall follow one of the two study options that is Plan A or Plan B.

3.3.1 Plan A

Students under Plan A are required to take two semesters of course work and two semesters of dissertation. To qualify for plan A, a student shall have completed all their course work and have a research proposal latest by the second week of semester three. A student on this Plan must complete the approved programme of coursework consisting of a minimum of 30 credit units during the year and must submit a Dissertation.

3.3.2 Plan B

Students under Plan B are required to take three semesters of coursework and one semester of a project. To qualify for plan B a student shall have completed all their coursework and also have a research proposal by the second week of the fourth semester. A student on this Plan must complete the approved programme of coursework that shall constitute 75% of the entire workload for the Degree. A student must submit a Report on a supervised Short Project carried out.

3.4 Duration

The duration for the MSc. CE degree programme is two (2) academic years comprising 4 semesters.

3.5 Tuition Fees

Tuition fees (functional fees not included) payable by the students will enable the College of Engineering, Design and Technology (CEDAT) to sustain the program. The tuition fees per semester for the programme shall be as shown below:

Nationality	**Ugandans (or East African residents)**		**Foreigners**	
	Semester Fees (Shs)	Annual Fees (Shs)	Semester Fees ($)	Annual Fees ($)
Full Time	2,850,000	5,900,000	2,800	5,600

4 Regulations

The general regulations for Master Degrees of Makerere University shall apply and these shall also include:

- Applications, registration, academic integrity, examination, research proposal writing and supervision;
- Guidelines for submission of progress reports and final dissertation for Plan A and report for Plan B shall apply.

4.1 Course Assessments

a) Each Course will be assessed on the basis of 100 total marks with proportions as follows:

Coursework – 40 and Examination – 60

b) A minimum of two course assignments/tests shall be required per course.

c) Course work shall consist of tests, group assignments and presentations in each semester.

d) Seminar series in the second year during which an evaluation of individual research study/project for both Plan A and B is done.

4.2 Grading of Courses

(a) Each Course will be graded out of a maximum of 100 marks and assigned an appropriate letter grade and a grade point as follows:

MARKS %	LETTER GRADE	GRADE POINT	INTERPRETATION
90 - 100	A+	5.0	Exceptional
80 - 89	A	5.0	Excellent
75 - 79	B+	4.5	Very good
70 - 74	B	4.0	Good
65 - 69	C+	3.5	Fairly good
60 - 64	C	3.0	Pass
55 - 59	D+	2.5	Marginal Fail
50 - 54	D	2.0	Clear Fail
45 - 49	E	1.5	Bad Fail
40 - 44	E-	1.0	Qualified Fail
Below 40	F	0.0	Qualified Fail

(b) The following additional letters will be used, where appropriate: -

W - Withdraw from Course;

I - Incomplete;

AU - Audited Course Only;

P - Pass;

F - Failure.

4.3 Minimum Pass Mark

A minimum pass grade for each course shall be 60% which is equivalent to 3.0 grade points.

4.4 Calculation of Cumulative Grade Point Average (CGPA)

The CGPA shall be calculated as follows: -

$$CGPA = \frac{\Sigma^{n}_{i=1}(GP_i * CU_i)}{\Sigma^{n}_{i=1} CU_i},$$

Where GP_i is the Grade Point score of a particular course i;

CU_i is the number of Credit Units of course i; and

n is the number of courses so far done.

4.5 Progression

Progression through the programme shall be assessed in three ways:

4.5.1 Normal Progress

This occurs when a student passes each course taken with a minimum Grade Point of 3.0.

4.5.2 Probationary

This is a warning stage and occurs if either the cumulative grade point average (CGPA) is less than 3.0 and/or the student has failed a core course. Probation is waved when these conditions cease to hold.

4.5.3 Discontinuation

When a student accumulates three consecutive probations based on the CGPA or the same core course(s), he/she shall be discontinued. A student who has failed to obtain at least the pass mark (60%)/ grade point of 3.0 during the third assessment in the same course(s) he/she had retaken shall be discontinued from his/her studies at the University. A student who has overstayed in an academic programme by more than two (2) years shall be discontinued from his /her studies at the university.

4.5.4 Re-taking a Course

A student may re-take any course when it is offered again in order to pass if the student had failed this course. A student may take a substitute elective, where the student does not wish to re-take a failed elective.

4.6 Weighting System

The weighting unit is the Credit Unit (CU). The Credit Unit is 15 contact hours per semester. A contact hour is equal to (i) one lecture hour, (ii) two practical hours or (iii) two tutorial hours

4.7 Master's Dissertation

Students are required to demonstrate their ability to independently formulate a detailed dissertation proposal, as well as develop and demonstrate their dissertation thoroughly.

a. A candidate shall be allowed to formally start on the dissertation after the second semester.
b. A candidate shall submit a dissertation proposal to the Academic board of the School of Engineering during the second semester of the first academic year.
c. The candidate shall execute the dissertation during second year (the third and fourth semesters).
d. The candidate shall submit a dissertation report by the end of the fourth semester. The dissertation should conform to the standing guidelines and regulations of the University on higher degrees.

4.7.1 Passing of a Dissertation

To pass the Dissertation, the candidate shall satisfy the Internal Examiner, External Examiner and Viva Voce Committee independently.

4.7.2 Revised Dissertation

A candidate, who fails to satisfy the examiners, shall re-submit a Revised Dissertation in accordance with the standing University guidelines for the dissertation examinations.

4.8 Master's Project

Students are required to demonstrate their ability to independently formulate a detailed Project Proposal, as well as develop and demonstrate their Project thoroughly.

a. A candidate shall be allowed to formally start on the Project after the third semester.
b. A candidate shall submit a Project Proposal to the Academic Board of the School of Engineering during the third semester.
c. The candidate shall execute the Project during the fourth semester.
d. The candidate shall submit the Project Report by the end of the fourth semester.

4.8.1 Passing of a Project

To pass the Project, the candidate shall satisfy the examiners in a written report and viva voce independently.

4.8.2 Revised Project Report

A candidate, who fails to satisfy the examiners, shall re-submit a Revised Project Report in accordance with the standing University guidelines for the project examinations.

4.9 Minimum Graduation Load

To qualify for the award of the degree of Master of Science in Civil Engineering (Plan A), a full-time

candidate is required to obtain a minimum of 34 credit units for courses passed including all the compulsory courses; and a Master's Dissertation (of 10 credit units) within a period stipulated by the School of Graduate Studies, usually not exceeding five (5) years from the date of registration.

To qualify for the award of the degree of Master of Science in Civil Engineering (Plan B), a candidate is required to obtain a minimum of 46 credit units for courses passed including all the compulsory courses; and the Master's Project (of 5 credit units) within a period stipulated by the School of Graduate Studies, usually not exceeding five (5) years from the date of registration.

4.10 Knowledge Areas Covered in the Program

The curriculum is based on 5 broad knowledge areas that make up practical and resourceful Civil Engineering Specialists. These are:-

1. Structural Engineering
2. Environmental Engineering
3. Geotechnical Engineering
4. Water Resources Engineering
5. Highway/Transportation Engineering

In addition to the above, students are to undertake courses in Research and Development (R & D) which are compulsory for all the above options.

4.11 Content Distribution by Knowledge Area

The current programme in addition to the aforementioned fields of specialisation (section 4.10) had Construction Management. However following the enacting of a new Department of Construction Management currently under the School of Built Environment and Land use Management, the field of Construction Management was moved to the newly created Department. Given the current market demands and innovations that have taken place both locally and globally in the fields of Geotechnical, Highway and Transportation Engineering, these necessitate a review of curriculum in these options that focuses on in-depth research. The revision of the curriculum has taken this into consideration by providing only Plan A in Geotechnical, Highways and Transportation Engineering options so as to build in-depth research capacity in these fields which is currently limited in the country. For the rest of the options: Structural, Environmental and Water resources Engineering, both Plan A and B have been provided.

Below is a summary of the current and revised distribution of the different course units in the different knowledge areas:-

- **STRUCTURAL ENGINEERING**

Current

YEAR 1			
Semester I	**Code**	**Course Name**	**Current**
Core Courses (*4courses for MEng and 5courses for MSc*)	CIV7101 & EMT 7102	Advanced Mathematics (3CU)	Offered to
	EMT7101 & 7103	Computer Application in Engineering (4CU)	Offered to
	CIV7102	Environmental Studies (3CU)	Offered to
	TEC 7101	Principles of Management (3CU)	Offered to
	MEC7101	Maintenance Engineering (3CU)	Offered to
	CIV7107	Advanced Structural Mechanics (3CU)	Offered to
	CIV7108	Advanced Structural Design (4CU)	Offered to
Semester II			
Core course (*1 MEng and 1 MSc*)	TEC7200	Research Methods (3CU)	Offered to
	TEC7201	Business Administration I (3CU)	Offered to
Elective Courses (*MEng selects 3 and MSc selects at least 4*)	CIV7207	Advanced Structural Mechanics (3CU)	Available fo
	CIV7208	Advanced Structural Design (4CU)	Available fo
	CIV7209 & 7231	Numerical Methods of Structural Analysis (3CU)	Available fo
	CIV7232	Structural Dynamics (3CU)	Available fo
	CIV7233	Stability of Structures (3CU)	Available fo
	CIV7234	Plates and Shells (3CU)	Available fo
	CIV7235	Applied Elasticity (3CU)	Available fo
	CIV7236	Durability and Maintenance of Structures (3CU)	Available fo
Recess Period			
Core Course	CIV7301	Business Administration II (3CU)	Available fo
	CIV7302	Research Methods (3CU)	Available fo
Electives (*select 2*)	CIV7317	Finite Element Methods (3CU)	Available fo
	CIV7318	Structural Dynamics (3CU)	
	CIV7319	Stability of Structures(3CU)	
	CIV7320	Plates and Shells(3CU)	

	CIV7321	Experimental Stress Analysis (2CU)	
	CIV7322	Applied Elasticity(3CU)	
	CIV7323	Durability and Maintenance of Structures(3CU)	
YEAR 2			
Semester I & II	**Code**	**Course Name**	**Current**
Core course	CE7200 & TEC8101	Research and Dissertation (MSc-12CU) MEng (8CU)	Offered to
		TOTAL CUs	**≥ 44 (MSc**

Revised

YEAR 1 (PLAN A & PLAN B)			
Semester I	**Code**	**Course Name**	**Proposed**
Core Course (*5 courses*)	RET7105	Statistics and Research Methods (3CU)	To be offered to MSc CE both Plan A Research Methods offered to MSc and CIV
	MEC7105	Principles of Management (3CU)	To be offered to MSc CE both Plan A & Pl to MEng only)
	CIV7115	Advanced Concrete Materials (3CU)	**New**-To be offered to MSc CE both Plan A
	CIV 7107	Advanced Structural Mechanics (3CU)	To be offered to MSc CE both Plan A & P to only M Eng)
	CIV 7108	Advanced Structural Design (3CU)	To be offered to MSc CE both Plan A & P offered to only M Eng)
Semester II			
Core course	EMT7201	Advanced Engineering Mathematics (3CU)	To be offered to MSc CE both Plan A Advanced Mathematics offered to MSc and
	MEC7203	Project Management (3CU)	To be offered to MSc CE both Plan A & P Management and Control offered under Co and MEng)
Electives (*select any 3*)	CIV7255	Finite Element Methods (3CU)	To be available for MSc CE both Plan A offered to only MEng in the recess period o

	CIV7232	Structural Dynamics (3CU)	To be available for MSc CE both Plan A offered to only MEng in the recess period o
	CIV7233	Stability of Structures (3CU)	To be available for MSc CE both Plan A offered to only MEng in the recess period o
	CIV7236	Durability and Maintenance of Structures (3CU)	To be available for MSc CE both Plan A offered to MEng in the recess period of Ye Semester II in Year 1)
	CIV7256	Elasticity and Plasticity (3CU)	To be available for MSc CE both Plan A Applied Elasticity offered to MEng in the re offered to MSc in Semester II in Year 1)
	CIV7257	Advanced Computational Mechanics (3CU)	**New**-To be available for MSc CE both Plan
	CIV7258	Analysis of Bridge Systems (3CU)	**New**-To be available for MSc CE both Plan
	CIV7259	Theory of Plates and Shells (3CU)	To be available for MSc CE both Plan A Plates and Shells offered to MEng in the re offered to MSc in Semester II in Year 1)
YEAR 2	**PLAN A**		
Semester I & II			
	Code	**Course Name**	**Proposed**
Core Course	CIV8100	Research and Dissertation (10CU)	Formerly CE7200 Research and Dissertati
	CIV8101	Seminar Series I (2CU)	**New**
	CIV8201	Seminar Series II (2CU)	**New**
	PLAN B		
Semester I			
	Code	**Course Name**	**Proposed**
Core Course	CIV8101	Seminar Series I (2CU)	**New**
	CIV8102	Advanced Reinforced Concrete (3CU)	**New**
	CIV8103	Behaviour and Design of Steel Structures (3CU)	
Electives	CIV8104	Fracture of Materials (3CU)	**New**

(*Select 2*)	CIV8105	Prestressed Concrete (3CU)	
	CIV8106	Advanced Structural Dynamics (3CU)	
	CIV8107	Continuum Mechanics (3CU)	
	CIV8108	Constitutive Modelling of Materials (3CU)	
	CIV8109	Boundary Element Method (3CU)	
	CIV8110	Mechanics of Composite Materials (3CU)	
Semester II			
	CIV8201	Seminar Series II (2CU)	**New**
	CIV8200	Research Project and Report (5CU)	**New**
		TOTAL CUs	**44 (MSc CE PLAN A); 51 (MSc CE PLAN**

- **ENVIRONMENTAL ENGINEERING**

Current

YEAR 1			
Semester I	**Code**	**Course Name**	**Current**
Core Course (*4 MEng and 5 MSc*)	CIV7101 & EMT 7102	Advanced Mathematics (3CU)	Offered to
	EMT7101 & 7103	Computer Applications in Engineering (4CU)	Offered to
	CIV7102	Environmental Studies (3CU)	Offered to
	TEC 7101	Principles of Management (3CU)	Offered to
	MEC7101	Maintenance Engineering (3CU)	Offered to
	CIV7105	Water Treatment (4CU)	Offered to
	CIV7106	Environmental Quality Management (4CU)	Offered to
Semester II			
Core course (*1 MEng and 1 MSc*)	TEC7200	Research Methods (3CU)	Offered to
	TEC7201	Business Administration I (3CU)	Offered to

Elective Courses (*MEng selects 3 and MSc selects at least 4*)	CIV7206 & CIV7225	Wastewater Treatment (4CU)	Available fo
	CIV7226	Water Transport and Distribution (3CU)	Available fo
	CIV7227	Industrial wastewater Treatment (3CU)	Available fo
	CIV7228	Solid Waste Management (3CU)	Available fo
	CIV7229	Air pollution (4CU)	Available fo
	CIV7230	Wetlands and Wastewater Treatment (4CU)	Available fo
	CIV7204	Unit Operation and Process (3CU)	Available fo
	CIV7205	Water Treatment (3CU)	Available fo
Recess Period			
Core Course	CIV7301	Business Administration II (3CU)	Available fo
	CIV7302	Research Methods (3CU)	Available fo
Electives (*select 2*)	CIV7309	Applied Hydraulics (4CU)	Available fo
	CIV7310	Water Transport and Distribution(3CU)	
	CIV7311	Environmental Engineering Laboratory (2CU)	
	CIV7312	Industrial wastewater Treatment 3CU)	
	CIV7313	Solid waste Management (3CU)	
	CIV7314	Environmental Quality Management (4CU)	
	CIV7315	Air pollution (4CU)	
	CIV7316	Wetlands and Wastewater Treatment (4CU)	
YEAR 2			
Semester I & II	**Code**	**Course Name**	**Current**
Core course	CE7200 & TEC8101	Research and Dissertation (MSc-12CU) MEng (8CU)	Offered to
		TOTAL CUs	**≥ 46 (MSc**

Revised

YEAR 1 (PLAN A & PLAN B)			
Semester I	**Code**	**Course Name**	**Proposed**
Core Course	RET7105	Statistics and Research Methods (3CU)	To be offered to MSc CE

(*5 courses*)			TEC7200 Research Me CIV7302 offered to MEng)
	MEC7105	Principles of Management (3CU)	To be offered to MSc CE TEC7101 offered to MEng
	CIV7116	Advanced Water Treatment (3CU)	To be offered to MSc CE b former CIV7105 Water Tre CIV7205 offered to MEng)
	CIV 7117	Air and Noise Pollution (3CU)	To be offered to MSc CE former CIV7229 Air Polluti offered to MEng)
	CIV 7118	Wastewater Treatment and Reuse (3CU)	To be offered to MSc CE former CIV7206 Wastewa and CIV7225 offered to M
Semester II			
Core Course	EMT7201	Advanced Engineering Mathematics (3CU)	To be offered to MSc CE EMT7102 Advanced Mat CIV7101 offered to MEng)
	MEC7203	Project Management (3CU)	To be offered to MSc CE CIV7201 Project Manage Construction Management
Electives (*select any 3*)	CIV7260	Decentralized Water supply and Sanitation (3CU)	**New** -To be available for M
	CIV7261	Solid waste Management and Recycling (3CU)	To be available for MSc C former CIV7228 Solid was and CIV7313 offered to M
	CIV7263	Policy, Laws and Institutions in Environmental Management (3CU)	**New** -To be available for M
	CIV7264	Water Quality Management (4CU)	**New** -To be available for M
YEAR 2	**PLAN A**		
Semester I & II			

	Code	Course Name	Proposed
Core Course	CIV8100	Research and Dissertation (10CU)	Formerly CE7200 Resea MSc
	CIV8101	Seminar Series I (2CU)	**New**
	CIV8201	Seminar Series II (2CU)	**New**
	PLAN B		
Semester I			
	Code	**Course Name**	**Proposed**
Core Course	CIV8101	Seminar Series I (2CU)	**New**
	CIV8111	Environmental Impact Assessments and Monitoring (4CU)	**New** – To be undertaken i Management, College of A Health Sciences (ENR710
Electives (*Select 3*)	CIV8112	Water Transport and Distribution (3CU)	To be available for MSc C CIV7226 offered to MSc a
	CIV8113	Planning of Community Water supply and Waste management (3CU)	**New**
	CIV8114	Groundwater Modelling (3CU)	**New**
	CIV8115	Environment and Development (3CU)	**New** – To be undertaken i Management, College of A Health Sciences (ENR710
	CIV 8116	Environmental Health and Waste Management (3CU)	**New**-To be undertaken i Management, College of Health Sciences (ENR810
Semester II			
Core Course	CIV8201	Seminar Series II (2CU)	**New**
	CIV8200	Research Project and Report (5CU)	**New**
		TOTAL CUs	**44 (MSc CE PLAN A); 5**

- **GEOTECHNICAL ENGINEERING**

Current

YEAR 1			
Semester I	**Code**	**Course Name**	**Current**
Core Course (*4 MEng and 5 Msc*)	CIV7101 & EMT 7102	Advanced Mathematics (3CU)	Offered to MEng a
	EMT7101 & 7103	Computer Applications in Engineering (4CU)	Offered to MEng a
	CIV7102	Environmental Studies (3CU)	Offered to MSc or
	TEC 7101	Principles of Management (3CU)	Offered to MEng c
	MEC7101	Maintenance Engineering (3CU)	Offered to MEng c
	CIV7109	Intermediate Soil Mechanics (3CU)	Offered to Msc
	CIV7110	Advanced Foundation Design (3CU)	Offered to Msc
Semester II			
Core course (*1 MEng and 1 MSc*)	TEC7200	Research Methods (3CU)	Offered to Msc on
	TEC7201	Business Administration I (3CU)	Offered to MEng c
Elective Courses (*MEng selects 3 and MSc selects at least 4*)	CIV7237 & 7212	Soil Improvement (3CU)	Available for Msc
	CIV7238	Earth Structures (3CU)	Available for MSc
	CIV7239	Advanced Laboratory (2CU)	Available for MSc
	CIV7240	Soil Structure Interaction (3CU)	Available for MSc
	CIV7241	Advanced Mechanics of Materials (3CU)	Available for MSc
	CIV7242	Slope Stability (3CU)	Available for MSc
	CIV7210	Intermediate Soil Mechanics (3CU)	Available for MEn
	CIV7211	Advanced Foundation Design (3CU)	Available for MEn
Recess Period			
Core Course	CIV7301	Business Administration II (3CU)	Available for MEn
	CIV7302	Research Methods (3CU)	Available for MEn
Electives (*select 2*)	CIV7324	Earth Structures (3CU)	Available for only
	CIV7325	Advanced Laboratory (2CU)	

	CIV7326	Soil Dynamics (3CU)	
	CIV7327	Soil Structure Interaction (3CU)	
	CIV7328	Advanced Mechanics of Materials (3CU)	
	CIV7329	Flow through porous Media (3CU)	
	CIV7330	Slope Stability (3CU)	
	CIV7331	Physical chemical behaviour of Soils (3CU)	
	CIV7332	Geohydrology (3CU)	
	CIV7333	Applied Hydrology for Engineers (3CU)	
YEAR 2			
Semester I & II	**Code**	**Course Name**	**Current**
Core course	CE7200 & TEC8101	Research and Dissertation (MSc-12CU) MEng (8CU)	Offered to MSc ar
		TOTAL CUs	**≥ 45 (MSc CE); ≥**

Revised

YEAR 1 (PLAN A)			
Semester I	**Code**	**Course Name**	**Proposed**
Core Course (*5 Courses*)	RET7105	Statistics and Research Methods (3CU)	Revised former TEC7200 MSc and CIV7302 offered
	MEC7105	Principles of Management (3CU)	Revised former TEC7101
	CIV7119	Advanced Soil Mechanics (3CU)	Revised formerCIV7109 Ir offered to MSc and CIV72
	CIV 7120	Advanced Foundation Engineering (3CU)	Revised former CIV7110 offered to MSc and CIV72
	CIV 7120	Static and Dynamic Soil-Structure Interaction (3CU)	Revised former CIV724 offered to MSc and CIV73
Semester II			
Core Course	EMT7201	Advanced Engineering Mathematics (3CU)	Revised former EMT71 offered to MSc and CIV71

	MEC7203	Project Management (3CU)	Revised former CIV7201 P Control offered under Con and MEng
Electives (*Select 3*)	CIV7265	Ground Improvement (3CU)	Revised former CIV7237 S MSc and CIV7212 offered
	CIV7238	Earth Structures (3CU)	Revised former CIV7238 c offered to MEng
	CIV7266	Laboratory and Field Soil Investigations (3CU)	**New** -To be available for (revised former CIV7239 to MSc and CIV7325 offer
	CIV7267	Slope Stability (3CU)	Revised former CIV7242 offered to MEng
YEAR 2 (PLAN A)			
Semester I & II			
	Code	**Course Name**	**Proposed**
Core Course	CIV8100	Research and Dissertation (10CU)	Formerly CE7200 Resear MSc
	CIV8101	Seminar Series I (2CU)	**New**
	CIV8201	Seminar Series II (2CU)	**New**
		TOTAL CUs	**44 (MSc CE PLAN A)**

- **WATER RESOURCES ENGINEERING**

Current

YEAR 1			
Semester I	**Code**	**Course Name**	**Current**
Core Course (*4 MEng*	CIV7101 & EMT 7102	Advanced Mathematics (3CU)	Offered to MEng a

and 5MSc)	EMT7101 & 7103	Computer Applications in Engineering (4CU)	Offered to MEng a
	CIV7102	Environmental Studies (3CU)	Offered to MSc or
	TEC 7101	Principles of Management (3CU)	Offered to MEng c
	MEC7101	Maintenance Engineering (3CU)	Offered to MEng c
	CIV7113	Water Resources Management (3CU)	Offered to Msc
	CIV7114	Advanced Surface Hydrology (3CU)	Offered to Msc
Semester II			
Core course (*1 MEng and 1 MSc*)	TEC7200	Research Methods (3CU)	Offered to Msc on
	TEC7201	Business Administration I (3CU)	Offered to MEng c
Elective Courses (*MEng selects 3 and MSc selects at least 4*)	CIV7249	Hydraulic Engineering (4CU)	Available for Msc
	CIV7250	Groundwater Investigation and Technology (3CU)	Available for MSc
	CIV7251	Statistical Analysis in Hydrology (3CU)	Available for MSc
	CIV7252	Urban Hydrology (3CU)	Available for MSc
	CIV7253	Fluid Mechanics (3CU)	Available for MSc
	CIV7254	Water Resources Project Planning (4CU)	Available for MSc
	CIV7216	Water Resources Management and Administration (3CU)	Available for MEn
	CIV7217	Groundwater Technology (3CU)	Available for MEn
	CIV7218	Irrigation and Drainage Engineering (4CU)	Available for MEn
Recess Period			
Core Course	CIV7301	Business Administration II (3CU)	Available for MEn
	CIV7302	Research Methods (3CU)	Available for MEn
Electives (*select 2*)	CIV7343	Hydraulic Engineering (4CU)	Available for only
	CIV7344	Water Resources System Engineering (3CU)	
	CIV7345	Water Resources Engineering Laboratory (2CU)	
	CIV7346	Applied Hydrology and Flood Control Engineering (3CU)	
	CIV7347	River Engineering (4CU)	
	CIV7348	Hydraulics Structures (3CU)	
	CIV7349	Water Resources Project Planning (4CU)	

YEAR 2			
Semester I & II	**Code**	**Course Name**	**Current**
Core course	CE7200 & TEC8101	Research and Dissertation (MSc-12CU) MEng (8CU)	Offered to MSc ar
		TOTAL CUs	**≥ 43 (MSc CE); ≥**

Revised

YEAR 1 (PLAN A & B)			
Semester I	**Code**	**Course Name**	**Proposed**
Core Course (*5 Courses*)	RET7105	Statistics and Research Methods (3CU)	To be offered to MSc CE TEC7200 Research Me CIV7302 offered to MEng)
	MEC7105	Principles of Management (3CU)	To be offered to MSc CE former TEC7101 offered to
	CIV7113	Water Resources Management (3CU)	To be offered to MSc CE b former CIV7113 offered to MEng
	CIV 7114	Advanced Surface Hydrology (3CU)	To be offered to MSc CE former CIV7114 offered to
	CIV 7124	Statistical Analysis in Hydrology (3CU)	To be offered to MSc CE former CIV7251 offered to
Semester II			
Core Course	EMT7201	Advanced Engineering Mathematics (3CU)	To be offered to MSc CE former EMT7102 Advance and CIV7101 offered to M
	MEC7203	Project Management (3CU)	To be offered to MSc CE b former CIV7201 Project M offered under Construction MEng)

	CIV7268	GIS System for Water Resources (3CU)	**New**-To be available for M
Electives (*select any 2*)	CIV7249	Hydraulic Engineering (3CU)	To be available for MSc C (revised former CIV7249 o offered to MEng)
	CIV7252	Urban Hydrology (3CU)	To be available for MSc (formerly CIV7252 offered
	CIV7264	Water Quality Management (3CU)	**New** -To be available for M
	CIV7269	Hydrological Data Processing and Modelling (3CU)	**New** -To be available for M
	CIV7270	Groundwater Hydrology (3CU)	**New** -To be available for M
YEAR 2	**PLAN A**		
Semester I & II			
	Code	**Course Name**	**Proposed**
Core Course	CIV8100	Research and Dissertation (10CU)	Formerly CE7200 Resear MSc
	CIV8101	Seminar Series I (2CU)	**New**
	CIV8201	Seminar Series II (2CU)	**New**
	PLAN B		
Semester I			
	Code	**Course Name**	**Proposed**
Core Course	CIV8101	Seminar Series II (2CU)	**New**
	CIV8117	Integrated Water Resources Management (3CU)	**New**
Electives (*Select 3*)	CIV8114	Groundwater Modelling (4CU)	**New**
	CIV8118	Irrigation Design and Management (4CU)	Revised former CIV7218 I

			Engineering offered to ME
	CIV8119	Hydropower Planning and Design (4CU)	**New**
	CIV8120	Water Resources Project Planning (3CU)	Revised former CIV7254 c offered to MEng
Semester II			
Core Course	CIV8201	Seminar Series II (2CU)	**New**
	CIV8200	Research Project and Report (5CU)	**New**
		TOTAL CUs	**44 (MSc CE PLAN A); 51**

- **HIGHWAY/TRANSPORTATION ENGINEERING**

Current

YEAR 1			
Semester I	**Code**	**Course Name**	**Current**
Core Course (*4 MEng and 5MSc*)	CIV7101 & EMT 7102	Advanced Mathematics (3CU)	Offered to MEng a
	EMT7101 & 7103	Computer Applications in Engineering (4CU)	Offered to MEng a
	CIV7102	Environmental Studies (3CU)	Offered to MSc or
	TEC 7101	Principles of Management (3CU)	Offered to MEng c
	MEC7101	Maintenance Engineering (3CU)	Offered to MEng c
	CIV7111	Transportation Systems Analysis (3CU)	Offered to Msc
	CIV7112	Highway Geometric Design (3CU)	Offered to Msc
Semester II			
Core course (*1 MEng and 1 MSc*)	TEC7200	Research Methods (3CU)	Offered to Msc on
	TEC7201	Business Administration I (3CU)	Offered to MEng c
Elective	CIV7243	Structural Design of Pavements (3CU)	Available for Msc

Courses (*MEng selects 3 and MSc selects at least 4*)	CIV7244	Performance and Rehabilitation of Pavements (4CU)	Available for MSc
	CIV7245	Pavement Materials (4CU)	Available for MSc
	CIV7246	Transportation Planning and Modelling (3CU)	Available for MSc
	CIV7247	Traffic Systems Analysis (3CU)	Available for MSc
	CIV7248	Mix Design (Bituminous and Concrete) (3CU)	Available for MSc
	CIV7213	Transportation Systems Analysis (3CU)	Available for MEn
	CIV7214	Structural Design of Pavements (3CU)	Available for MEn
	CIV7215	Performance and Rehabilitation of Pavements (3CU)	Available for MEn
Recess Period			
Core Course	CIV7301	Business Administration II (3CU)	Available for MEn
	CIV7302	Research Methods (3CU)	Available for MEn
Electives (*select 2*)	CIV7334	Highway Geometric Design (3CU)	Available for only
	CIV7335	Pavement Materials (4CU)	
	CIV7336	Transportation Planning and Modelling (3CU)	
	CIV7337	Transport System Analysis (3CU)	
	CIV7338	Airport Design (3CU)	
	CIV7339	Mix Design (Bituminous and Concrete) (3CU)	
	CIV7340	Advanced Pavement Design (3CU)	
	CIV7341	Air photo Interpretation (4CU)	
	CIV7342	Railway Engineering (3CU)	
YEAR 2			
Semester I & II	**Code**	**Course Name**	**Current**
Core course	CE7200 & TEC8101	Research and Dissertation (MSc-12CU) MEng (8CU)	Offered to MSc ar
		TOTAL Cus	**≥ 40 (MSc CE); ≥**

Revised

YEAR 1 (PLAN A)			
Semester I	**Code**	**Course Name**	**Proposed**
Core Course (*5 Courses*)	RET7105	Statistics and Research Methods (3CU)	Revised former TEC7200 MSc and CIV7302 offered
	MEC7105	Principles of Management (3CU)	Revised former TEC7101
	CIV 7112	Highway Geometric Design (3CU)	Revised former CIV7112 offered to MEng)
	CIV7122	Transport Systems Analysis (3CU)	Revised former CIV7247 o offered to MEng
	CIV 7123	Airport Design (3CU)	Revised former CIV7338
Semester II			
Core Courses	EMT7201	Advanced Engineering Mathematics (3CU)	Revised former EMT71 offered to MSc and CIV71
	MEC7203	Project Management (3CU)	Revised former CIV7201 P Control offered under Con and MEng
Electives (*select any 3*)	CIV7245	Pavement Materials (3CU)	Revised former CIV7245 o offered to MEng
	CIV7243	Structural Design of Pavements (3CU)	Revised former CIV7243 o offered to MEng only
	CIV7244	Performance and Rehabilitation of Pavements (3CU)	Revised former CIV7244 o offered to MEng only
	CIV7246	Transportation Planning and Modelling (3CU)	Revised former CIV7246 offered to MEng only
	CIV7271	Mix Design (Bituminous and Concrete) (3CU)	Revised former CIV7248 o offered to MEng
	CIV7272	Traffic Systems Analysis (3CU)	Revised former 7247 offer
YEAR 2 (PLAN A)			
Semester I & II			
	Code	**Course Name**	**Proposed**

Core Course	CIV8100	Research and Dissertation (10CU)	Formerly CE7200 Resear MSc
	CIV8101	Seminar Series I (2CU)	**New**
	CIV8201	Seminar Series II (2CU)	**New**
		TOTAL Cus	**44 (MSc CE PLAN A)**

5. Curriculum for the revised Master of Science in Civil Engineering

The current programme structure is such that:

Period	MSc	MEng
Year 1		
Semester I	5 Core courses	4 Core courses
Semester II	1 Core course and 4 Electives from any of the specialised options	1 Core course and 3 Electives from any of the specialised options
Recess Term	-	2 Core courses and 2 Electives from any of the specialised options
Year 2		
Semester 1 & II	Research and Dissertation	Research and Dissertation

The revised programme structure shall be as follows:

Period	MSc CE Plan A	MSc CE Plan B
Year 1		
Semester I	5 Core courses	
Semester II	2 Core Courses and 3 Electives	
Year 2		
Semester I	Seminar Series I; Research and Dissertation	EITHER 3 Core courses and 3 electives in Structural Engineering option OR 2 Core courses and 3 Electives from either Environmental Engineering or Water Resources Engineering options (Seminar Series I is among the core courses)
Semester II	Seminar Series II; Research and Dissertation	Seminar Series II; Research Project and Report

The revised programme considering the different knowledge fields or specialised options is presented in the following table.

STRUCTURAL ENGINEERING

YEAR 1 (PLAN A & B)

SEMESTER I – 5 core courses						
Code	**Name**	**LH**	**PH**	**TH**	**CH**	**CU**
RET 7105	Statistics and Research Methods	45	-	-	45	3
MEC 7105	Principles of Management	45	-	-	45	3
CIV 7115	Advanced Concrete Materials	45	-	-	45	3

CIV 7107	Advanced Structural Mechanics	45	-	-	45	3
CIV 7108	Advanced Structural Design	30	30	-	45	3
SEMESTER II – 2 Core courses and 3 Electives						
Core courses						
EMT 7201	Advanced Engineering Mathematics	45	-	-	45	3
MEC 7203	Project Management	45	-	-	45	3
Electives						
CIV 7232	Structural Dynamics	45	-	-	45	3
CIV 7233	Stability of Structures	45	-	-	45	3
CIV 7236	Durability and Maintenance of Structures	45	-	-	45	3
CIV 7255	Finite Element Methods	45	-	-	45	3
CIV 7256	Elasticity and Plasticity	45	-	-	45	3
CIV 7257	Advanced Computational Mechanics	45	-	-	45	3
CIV 7258	Analysis of Bridge Systems	45	-	-	45	3
CIV 7259	Theory of Plates and Shells	45	-	-	45	3

YEAR 2

PLAN A – Semester I & II

Code	Name	LH	PH	TH	CH	CU
Core courses						
CIV 8100	Research and Dissertation	-	300	-	150	10
CIV 8101	Seminar Series I	-	30	-	30	2
CIV 8201	Seminar Series II	-	30	-	30	2

PLAN B

Semester I – 3 Cores and 2 Electives						
Core courses						
CIV 8101	Seminar Series I	-	30	-	30	2
CIV 8102	Advanced Reinforced Concrete	45	-	-	45	3
CIV 8103	Behaviour and Design of Steel Structures	45	-	-	45	3
Electives						
CIV 8104	Fracture of Materials	45	-	-	45	3
CIV 8105	Prestressed Concrete	45	-	-	45	3
CIV 8106	Advanced Structural Dynamics	45	-	-	45	3
CIV 8107	Continuum Mechanics	45	-	-	45	3

CIV 8108	Constitutive Modelling of Materials	45	-	-	45	3
CIV 8109	Boundary Element Method	45	-	-	45	3
CIV 8110	Mechanics of Composite Materials	45	-	-	45	3
Semester II						
Core courses						
CIV 8200	Research Project and Report	-	150	-	75	5
CIV 8201	Seminar Series II	-	30	-	30	2
	TOTAL Cus	**44 (PLAN A); 51 (PLAN B)**				

ENVIRONMENTAL ENGINEERING

YEAR 1 (PLAN A & B)

SEMESTER I – 5 core courses						
Code	**Name**	**LH**	**PH**	**TH**	**CH**	**CU**
RET 7105	Statistics and Research Methods	45	-	-	45	3
MEC 7105	Principles of Management	45	-	-	45	3
CIV 7116	Advanced Water Treatment	30	30	-	45	3
CIV 7117	Air and Noise Pollution	30	30	-	45	3
CIV 7118	Wastewater Treatment and Reuse	30	30	-	45	3
SEMESTER II – 2 Core courses and 3 Electives						
Core courses						
EMT 7201	Advanced Engineering Mathematics	45	-	-	45	3
MEC 7203	Project Management	45	-	-	45	3
Electives						
CIV 7260	Decentralized Water Supply and Sanitation	45	-	-	45	3
CIV 7261	Solid waste Management and Recycling	45	-	-	45	3
CIV 7263	Policy, Laws and Institutions in Environmental Management	45	-	-	45	3
CIV 7264	Water Quality Management	30	30	-	45	3

YEAR 2

PLAN A – Semester I & II

Code	**Name**	**LH**	**PH**	**TH**	**CH**	**CU**
Core courses						
CIV 8100	Research and Dissertation	-	300	-	150	10

CIV 8101	Seminar Series I	-	30	-	30	2
CIV 8201	Seminar Series II	-	30	-	30	2

PLAN B

SEMESTER I – 2 Core courses and 3 Electives						
Core courses						
CIV 8101	Seminar Series I	-	30	-	30	2
CIV 8111	Environmental Impact Assessments and Monitoring	40	20	20	60	4
Electives						
CIV 8112	Water Transport and Distribution	45	-	-	45	3
CIV 8113	Planning of Community Water Supply and Waste Management	45	-	-	45	3
CIV 8114	Groundwater Modelling	45	30	-	45	3
CIV 8115	Environment and Development	30	-	30	45	3
CIV 8116	Environmental Health and Waste Management	30	10	20	45	3
SEMESTER II						
Core courses						
CIV 8200	Research Project and Report	-	150	-	75	5
CIV 8201	Seminar Series II	-	30	-	30	2
	TOTAL CUs	**44 (PLAN A); 52 (PLAN B)**				

GEOTECHNICAL ENGINEERING (PLAN A ONLY)

YEAR 1

SEMESTER I – 5 core courses						
Code	**Name**	**LH**	**PH**	**TH**	**CH**	**CU**
RET 7105	Statistics and Research Methods	45	-	-	45	3
MEC 7105	Principles of Management	45	-	-	45	3
CIV 7119	Advanced Soil Mechanics	45	-	-	45	3
CIV 7120	Advanced Foundation Engineering	45	-	-	45	3
CIV 7121	Static and dynamic Soil-Structure Interaction	45	-	-	45	3
SEMESTER II – 2 Core courses and 3 Electives						
Core courses						
EMT 7201	Advanced Engineering Mathematics	45	-	-	45	3
MEC 7203	Project Management	45	-	-	45	3
Electives						
CIV 7238	Earth Structures	45	-	-	45	3
CIV 7265	Ground Improvement	45	-	-	45	3

CIV 7266	Laboratory and Field Soil Investigations	30	30	-	45	3
CIV 7267	Slope Stability	45	-	-	45	3

YEAR 2

Semester I & II

Code	Name	LH	PH	TH	CH	CU
Core courses						
CIV 8100	Research and Dissertation	-	300	-	150	10
CIV 8101	Seminar Series I	-	30	-	30	2
CIV 8201	Seminar Series II	-	30	-	30	2
	TOTAL CUs	**44**				

WATER RESOURCES ENGINEERING						
YEAR 1 (PLAN A & PLAN B)						
SEMESTER I – 5 core courses						
Code	**Name**	**LH**	**PH**	**TH**	**CH**	**CU**
RET 7105	Statistics and Research Methods	45	-	-	45	3
MEC 7105	Principles of Management	45	-	-	45	3
CIV 7113	Water Resources Management	45	-	-	45	3
CIV 7114	Advanced Surface Hydrology	45	-	-	45	3
CIV 7124	Statistical Analysis in Hydrology	45	-	-	45	3
SEMESTER II – 3 Core courses and 2 Electives						
Core courses						
EMT 7201	Advanced Engineering Mathematics	45	-	-	45	3
MEC 7203	Project Management	45	-	-	45	3
CIV 7268	GIS System for Water Resources	30	30	-	45	3
Electives						
CIV 7249	Hydraulic Engineering	30	30	-	45	3
CIV 7252	Urban Hydrology	45	-	-	45	3
CIV 7264	Water Quality Management	30	30	-	45	3
CIV 7269	Hydrological Data Processing and Modelling	30	30	-	45	3
CIV 7290	Groundwater Hydrology	45	-	-	45	3

YEAR 2 (PLAN A)

Semester I & II

Code	Name	LH	PH	TH	CH	CU
Core courses						
CIV 8100	Research and Dissertation	-	300	-	150	10
CIV 8101	Seminar Series I	-	30	-	30	2
CIV 8201	Seminar Series II	-	30	-	30	2

PLAN B

SEMESTER I – 2 Core course and 3 Electives						
Core courses						
CIV 8101	Seminar Series I	-	30	-	30	2
CIV 8117	Integrated Water Resources Management	30	10	20	45	3
Electives						
CIV 8114	Groundwater Modelling	30	30	-	45	3
CIV 8118	Irrigation Design and Management	30	30	-	45	3
CIV 8119	Hydropower Planning and Design	30	30	-	45	3
CIV 8120	Water Resources Project Planning	45	-	-	45	3
SEMESTER II						
Core courses						
CIV 8200	Research Project and Report	-	150	-	75	5
CIV 8201	Seminar Series II	-	30	-	30	2
	TOTAL CUs	**44 (PLAN A); 51 (PLAN B)**				

HIGHWAY/TRANSPORTATION ENGINEERING (PLAN A ONLY)						
YEAR 1						
SEMESTER I – 5 core courses						
Code	**Name**	**LH**	**PH**	**TH**	**CH**	**CU**
RET 7105	Statistics and Research Methods	45	-	-	45	3
MEC 7105	Principles of Management	45	-	-	45	3
CIV 7112	Highway Geometric Design	45	-	-	45	3
CIV 7122	Transport Systems Analysis	45	-	-	45	3
CIV 7123	Airport Design	45	-	-	45	3
SEMESTER II – 2 Cores and 3 Electives						
Core Courses						
EMT 7201	Advanced Engineering Mathematics	45	-	-	45	3
MEC 7203	Project Management	45	-	-	45	3

Elective courses						
CIV 7243	Structural Design of Pavements	45	-	-	45	3
CIV 7244	Performance and Rehabilitation of Pavements	30	30	-	45	3
CIV 7245	Pavement Materials	30	30	-	45	3
CIV 7246	Transportation Planning and Modelling	45	-	-	45	3
CIV 7271	Mix Design (Bituminous and Concrete)	45	-	-	45	3
CIV 7272	Traffic Systems Analysis	45	-	-	45	3

YEAR II

SEMESTER I & II						
CIV 8100	Research and Dissertation	-	300	-	150	10
CIV 8101	Seminar Series I	-	30	-	30	2
CIV 8201	Seminar Series II	-	30	-	30	2
	TOTAL CUs	**44**				

6 Detailed Curriculum

6.1 Semester I

6.1.1 RET7105 Statistics and Research Methods (3 CU)

Course Description

This course presents the fundamentals, concepts and methods used in the analysis of data. It covers definitions, methods of computation of the various measures of data summarization. The course will also cover advanced engineering research skills, focusing on research design, design of data collection instruments, implementation of data collection plans, and principles of research report writing and dissemination.

Objectives

The aims of this course are to:

- Provide students with a strong knowledge base for mathematical analysis of energy systems.
- Equip students with background and fundamental knowledge behind the techniques for analyzing a vast amount of data for different scenarios with ease
- Equip students with the skills to use the tools for handling large amounts of data Explain to students the role of research in knowledge creation
- Instruct students on how research is conducted practically and in academic circles

Learning Outcomes

At the end of this course, a student should be able to:

- Explain the mathematical concepts of data occurrence and analysis

- Apply the different methods of displaying and reporting data
- Compute the various quantities used to summarize data
- Distinguish among the different scenarios of occurrence of events
- To test different data sets to find which models best describe them
- Explain the various terminology used in research methods
- Describe the various research designs applied in research
- Develop a research proposal including identification of a research problem, formulation of research objectives, description of the methodology and the data analysis techniques
- Identify shortcoming in research proposals, designs and reports

Mode of teaching/delivery

The teaching of students will be conducted through lectures, tutorials, short classroom exercises, case studies, group discussions among the students and projects aimed at solving real life problems. The lecture material will be availed to the students in advance to enable them have prior reading. Solving real life problems in each theme or a number of topics will enhance the students' understanding of the problem based learning techniques.

Method of Assessment

Assessment will be done through coursework which will include assignments, class room and take home tests, project work and presentations and a written examination. Course work will carry a total of 40% and written examination carries 60%. Coursework marks will be divided into; Assignments 5%, Tests 10% and Practical/project Work 25%.

Course Content

1 Research Methods

1.1 ***Introduction*** ***(2CH)***

- Definition of Research
- Role of Research in the Engineering Profession
- Types of Research (Basic Vs Applied; Primary Vs Secondary; Exploratory Vs Constructive Vs Empirical)
- Research Processes (The Scientific Vs Historical Research Process)
- Information Literacy Strategies
- Research Funding
- Research and Publishing

1.2 ***Elements of General Academic Writing*** ***(3CH)***

- The Writing Process (Invention, Composition and Revision)
- Research Concept Note (Synopsis)
- Proposal
- Thesis Report
- Papers
- Abstracts
- Formatting Style (MLA Vs APA)

1.3 ***Identifying and Formulating a Research Problem*** ***(2CH)***

- Definition of Research Problem
- Identify a Research Problem (Sources of Research Problems)
- Testing the Feasibility of the Research Problem
- Formulating a Research Problem
- Statement of the Problem
- Components of a Problem Statement

1.4 ***Developing Other Proposal Components*** ***(5CH)***

- Formulating a Research Title
- Formulating and Stating the Research Objectives
- Stating the Research Justification
- Literature Review
- The Research Methodology
- The Research Resources Plan (Work plan, and Budget)
- References and Bibliography
- Appendices
- Pagination of Research Proposal

1.5 ***Research Ethics*** ***(6CH)***

- Intellectual Property Rights (Makerere IPM Policy and other International IPM Policies)
- Research Ownership and Mandate of Researcher
- Research and Citations (Notation and Standards)
- Plagiarism (Definition, manifestation, and consequences)
- Authenticity of Facts and Opinions (Proper Research Language and avoiding weasel word and fallacies)
- Rights of Human and Animal Survey Respondents

1.6 ***Data Collections and Analysis*** ***(6CH)***

- Designing and Executing a Survey
- Sources of Data
- Sample and Populations
- Sampling Methods
- Quantitative and Qualitative Approaches
- Data Collections Instruments and Methods, their Context and Limitations (Questionnaires Vs Interview Vs Check Lists)
- Questionnaire Design: Types of Questions, Response Rate and Sample Size
- Coding Data: Missing Values, Open Ended Questions

1.7 ***Research Designing*** ***(3CH)***

- Choosing an Operational Definition
- Experimental and Non-Experimental Designs
- Internal and External Validity and Associated Threats
- Groups Vs Repeated Measure Design

1.8 ***Presentation of Research*** ***(1CH)***

- Oral Presentation (Proposal and Viva Voce)
- Use of Presentation Aides
- Use of Graphics and Animations in Presenting Research
- Presentation Language

2 Statistics and Data Analysis

2.1 *Introduction* ***(2CH)***

- Definition of Statistics
- Role of Statistics in Engineering Research
- Misuse and Abuse of Statistics
- Data Measurement

2.2 *Descriptive Statistics* ***(6CH)***

- Introduction
- Frequency Distributions: Histograms and bar charts, The shape of a distribution, Determining if skewness and kurtosis are significantly non-normal
- Central Tendency: Measures of central tendency, Choosing a measure of central tendency
- Variability: Sums of squares, Variance, Standard deviation
- The Normal Distribution
- Transformations: Dichotomisation, Z-scores, The standard normal distribution, Normalising
- Correlation and Regression
- Descriptive Statistics Using Data Analysis Software

2.3 *Inferential Statistics* ***(9CH)***

- Introduction
- Null and alternative hypotheses
- Hypothesis testing
- Type I and Type II Errors
- Analysis of Variance (ANOVA)
- Inferential Statistics using Data Analysis Software

Reading /Reference Materials

John W. Creswell, (2006). *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches*. Sage Publications, Inc; 3rd Edition. ISBN-10: 1412965578, ISBN-13: 978-1412965576

Donald H. McBurney and Theresa L. White, (2006). *Research Methods*, Wadsworth Publishing; 7 Edition. ISBN-10: 0495092088, ISBN-13: 978-0495092087

Anthony M. Graziano and Michael L. Raulin (2006). *Research Methods: A Process of Inquiry*. Allyn & Bacon; 6 Edition. ISBN-10: 0205484751, ISBN-13: 978-0205484751

Kenneth Bordens and Bruce Barrington Abbott, (2007). *Research Design and Methods: A Process Approach*. McGraw-Hill Humanities/Social Sciences/Languages; 7th Edition. ISBN-10: 0073129062, ISBN-13: 978-0073129068

Jay L. Devore (2008). *Probability and Statistics for Engineering and the Sciences*, 7th Edition, Cole Publishing Company. ISBN 10: 0495557447 / 0-495-55744-7; ISBN 13: 9780495557449

Patrick Neil & Steve Chapman (1985). *Research Methods*, 3rd Edition, Poutledge Taylor & Francis Group.

Brenda Laurel (ed.) (2004). *Design Research; Methods and Perspecitves*, MIT Press.

6.1.2 MEC7101 Principles of Management (3 CU)

Course Description

This course will enable students to develop short and long-range plans to effectively accomplish organizational goals. Through the use of terminology, exercises and case studies, students will be able to give a critical appraisal of real life situations involving organizing, staffing and motivating others. The student will also learn tools to aid in problem solving, valuing diversity and coping with change. The principles learned in this course will allow the student to effectively work with and through others in an organization. The principles are relevant to any type of organization or group, empowering the student to lead others, negotiate, embrace change and better understand the role of business in society. Both principles and practices of management as an academic discipline as well as a profession are surveyed, examined, and reviewed. Students will acquire knowledge through the textbook, and the assigned reading material as well as the material accessible through the web and apply them to specific real world management phenomenon. The course focuses on the fundamentals of the practice of management, including administrative, organizational and behavioural theories. It explores the functions of management and the aspects of the organizational environment.

Objectives

- to understand the roles and functions of managers at various (entry, middle and the top) levels
- to explain the relationships between organizational mission, goals, and objectives
- to comprehend the significance and necessity of managing stakeholders
- to conceptualize how internal and external environment shape organizations and their responses
- to demonstrate empirical understanding of various organizational processes and behaviours and the theories associated with them
- to demonstrate critical thinking skills in identifying ethical, global and diversity issues in planning, organizing, controlling and leading functions of management
- to understand organizational design and structural issues

Learning Outcomes

On completion of this course the students should be able to:

- Describe the functions of management

- Outline the historical theories relating to modern management
- Explain the role of management within a business setting
- Outline managerial decision making.
- Identify the steps of problem solving and decision making in organizations
- Apply knowledge of managerial practices to case studies
- Recognize challenges in the achievement of good managerial performance
- Describe human resource planning and staffing processes needed to achieve optimal performance
- Prepare a business forecast and budget
- Illustrate how business ethics and social responsibility apply to organizations
- Define change and tress in organizations and prepare a plan to implement changes using case studies
- Describe formal and informal organizational communication processes and how to influence employees.

Mode of teaching/delivery

The teaching of students will be conducted through lectures, tutorials, short classroom exercises, case studies, group discussions among the students and projects aimed at solving real life problems. The lecture material will be availed to the students in advance to enable them have prior reading. Solving real life problems in each theme or a number of topics will enhance the students' understanding of the problem based learning techniques.

Method of Assessment

Assessment will be done through coursework which will include assignments, class room and take home tests, project work and presentations and a written examination. Course work will carry a total of 40% and written examination carries 60%. Coursework marks will be divided into; Assignments 5%, Tests 10% and Practical/project Work 25%.

Course Content

1 ***Historical Perspectives of Management*** ***(3CH)***

- The behavioural approach to management
- The management science approach
- The contingency approach
- The system approach

2 ***Principles of Planning*** ***(6CH)***

- Defining planning
- Purposes of planning
- Advantages and potential disadvantages of planning
- Management by objectives
- Planning tools
- Strategic planning
- Forecasting and budgeting

3 ***The Management Task*** ***(3CH)***

- The Role of management
- Defining management

- The management process, management functions
- Management goal attainment
- Management and organizational resources

4 ***Fundamentals of Organizing*** ***(6CH)***

- The definition of organizing
- The organizing process
- The organizing subsystem
- Classical organizing theory

5 ***Leadership and Effective Communication*** ***(6 CH)***

- Defining leadership; leader vs. manager
- Leadership behaviours
- Transformational Leadership
- Coaching
- Entrepreneurial leadership

6 **Controlling for Productivity** ***(6CH)***

- Defining production and productivity
- Quality and productivity
- Operations management
- Operations control
- Using control tools to control organizations

7 ***Managerial Ethics and Social Responsibility*** ***(9CH)***

- Fundamentals of social responsibility
- Areas of corporate social responsibility
- Social responsiveness and decision making
- Influencing individuals performing social responsibility activities
- A definition of ethics
- Creating an ethical workplace

8 ***Making Good Business Decisions*** ***(6CH)***

- Types of decisions
- Elements of the decision situation
- The decision making process
- Decision making conditions
- Decision making tools
- Processes for making group decisions

Reading/Reference Materials

Charles W. L. Hill and Steven McShane (2006*) Principles of Management*. McGraw-Hill/Irwin; 1st Edition. ISBN-10: 0073530123, ISBN-13: 978-0073530123

Gary Dessler (2003). *Management: Principles and Practices for Tomorrow's Leaders*, Prentice Hall; 3rd Edition. ISBN-10: 0131009923, ISBN-13: 978-0131009929

Ellen A. Benowitz(2001). *Principles of Management*. Cliffs Notes. ISBN-10: 076456384X, ISBN-13: 978-0764563843

6.1.3 CIV7115 Advanced Concrete Materials (3 CU)

Course Description
This course deals with advances in concrete materials and their design with special emphasis placed on state of the art developments in the area.

Objectives
- To enable the student obtain a deeper understanding of concrete materials, since they form the main bulk of construction material in building industry.
- Appreciate the basis of innovations occurring in development of concrete materials both locally and internationally.

Course Content
Properties of concrete constituents; types of cements and their composition; cement hydration; microstructure of hydrated cement paste and its influence on strength, shrinkage and creep; chemical admixtures; alternate cement matrices; concrete durability and sustainability; introduction to repair materials.
Special concretes including high strength, high performance, fiber reinforced, light weight; local durability problems and various methods of protection; concept of durable design and code specifications. Emphasis will be placed on state of the art developments in the area.

Learning Outcomes
On completing the course the student should be able to:
- § appreciate the effects of constituents such as aggregates and cements on the properties of concrete
- § to design and specify appropriate concrete for different applications.

Mode of teaching/delivery

The course shall be conducted through lectures, practicals and site visits.

Mode of Assessment
Assessment will be done through continuous interim assessments (assignments, practicals and tests) and a final examination. Interim assessment will carry a total of 40% and final examination will carry 60% of the final grade mark.

Proposed Staff
Dr. Yasin Naku Ziraba
Eng. Paul Mujugumbya
Prof. Jackson Mwakali
Eng. Moses Matovu

Reading/Reference Materials
The instructor is to compile the reading list from several textbooks, journals, etc readily available in this area.

6.1.4 CIV7107 Advanced Structural Mechanics (3 CU)

Course Description

This course deals with more advanced topics in Strength and Mechanics of Engineering Materials and application of the elementary theory to structural behavior of structural elements and the criteria governing their failure.

Objectives
To enable the student learn the fundamental laws of mechanics governing the behavior of materials and so assess their design based on the determined failure theories.

Course Content
Principles of analysis of mechanical designs with respect to strength or deformation criteria. Elastic and inelastic failure criteria, energy methods, effect of temperature, stress concentrations and fatigue.
Unsymmetrical bending of beams; shear center; bending of curved beams; torsion of prismatic bars; beams on elastic foundations; introduction to Cartesian tensors; tensorial transformation of stress; Mohr's circle for 3-D stress transformation; dyadic symbols; finite and infinitesimal strain tensors; Mohr's circle for 3-D strain; constitutive equations for anisotropic materials and application to composite laminates: theories of yield and fracture

Learning Outcomes
On completing the course the student should be able to analyse stresses, strains and deformations of structural elements and asses their mode of failure based on the learned failure theories

Mode of teaching/delivery
The course shall be conducted through lectures.

Mode of Assessment
Assessment will be done through continuous interim assessments (assignments and tests) and a final examination. Interim assessment will carry a total of 40% and final examination will carry 60% of the final grade mark.

Proposed Staff
Dr. Yasin Naku Ziraba

Reading/Reference Materials
The instructor is to compile the reading list from several textbooks, journals, etc readily available in this area.

6.1.5 CIV7108 Advanced Structural Design (3 CU)

Course Description
This course deals advanced design in steel and concrete materials, of building components that range from foundations to the entire superstructure.

Objectives
To enable the student design more complex building structures using the steel and concrete.

Course Content
Design of steel structures: Theory and practice in design of structural steel and connections in steel, aluminium and concrete; behavior of frames and complex (tall) buildings. Advanced concrete design: general aspects of design, typical building layout patterns; forces on buildings and

earthquake-resistant design; reinforced concrete design: shear walls, multiple column footings, pile caps, brackets and corbels, torsion and shear, effects of column slenderness, two-way slabs. Prestressed concrete design: analysis of prestressed concrete simple beams, ultimate limit state, short-term and long-term deflections; continuous beams-elastic theory, concepts of line of pressure and design procedures. Advanced foundation design: advanced analysis in shear strength of cohesion-less and cohesive soils, slope stability analyses, analysis and design of anchored bulkheads and cofferdams, stress distribution, settlement analysis, lateral earth pressure (including tie-back systems and earth reinforcement), bearing capacity of shallow and pile foundations and laterally loaded piles.

Learning Outcomes
On completing the course the student should be able to design more complex building structures using the steel and concrete.

Mode of teaching/delivery
The course shall be conducted through lectures, and site visits.

Mode of Assessment
Assessment will be done through continuous interim assessments (assignments and tests) and a final examination. Interim assessment will carry a total of 40% and final examination will carry 60% of the final grade mark.

Proposed Staff
Prof. Jackson Mwakali
Eng. Paul Mujugumbya

Reading/Reference Materials
The instructor is to compile the reading list from several textbooks, journals, etc readily available in this area.

6.1.6 CIV7116 Advanced Water Treatment (3 CU)

Course Description
This course provides the need for water treatment, the importance of providing safe water for the public and the theory and operation of conventional and advanced water treatment processes. It introduces advanced information on the theory and operation of conventional water treatment plant processes. In addition, more advanced processes including advanced oxidation for removal disinfection by-products precursors/ natural organic matter and resistant organisms like cryptosporidium; chemical precipitation/softening; demineralization/ desalination; handling and disposal of process wastes are presented.

Objectives
The aim of this course is to provide an overview of both the theoretical and practical aspects of conventional and advanced water technology for surface water treatment.

Course Content
1. *Introduction* ***(3CH)***
1.1 Drinking water quality standards, regulations, and goals

1.2 Health and aesthetic aspects of water quality
1.3 Guide to selection of water treatment processes
1.3.1 Water supply approaches
1.3.2 Factors influencing process selection
1.3.3 Evaluating process options

2. *Coagulation and Flocculation Processes* ***(5CH)***
2.1 Definitions
2.2 Contaminants
2.3 Stability of particle suspensions
2.4 Coagulants
2.5 The flocculation process

3. *Granular Bed and Pre-coat Filtration* ***(5CH)***
3.1 An overview of potable water filtration
3.2 Types of filter media and arrangement
3.3 Rapid granular bed filtration
3.3.1 Theory of rapid filtration
3.3.2 Rapid filter performance
3.3.3 Direct filtration
3.3.4 Flow control in filtration
3.3.5 Backwashing of rapid filters
3.3.6 Problems in rapid filters
3.4 Pressure granular bed filters
3.4 Pre-coat filtration

4. *Chlorination and Advanced Oxidation Processes* ***(5CH)***
4.1 Principles and applications of oxidation processes
4.2 Oxidants used in water treatment
4.3 Mode of action of disinfectants/ oxidants
4.4 Ultraviolet processes
4.5 Formation of disinfection (and oxidation) by-products
4.6 Use of multiple disinfectants

5. *Desalination and Membrane Filtration* ***(2CH)***
5.1 Classifications and configurations of membrane processes
5.2 Membrane properties and rejection characteristics
5.3 Mass transport and separation
5.4 Process design criteria

6. *Ion Exchange Technology* ***(3CH)***
6.1 Introduction and theory of ion exchange
6.2 Ion Exchange materials and reactions
6.3 Column processes and calculations
6.4 Design considerations
6.5 Applications of ion exchange and adsorption

7. *Chemical Precipitation* ***(2CH)***

7.1 Fundamentals of chemical precipitation
7.2 Water softening by chemical precipitation
7.3 Removal of nominal organic material
7.4 Removal of other contaminants by precipitation

8. *Adsorption of Organic Compounds* ***(3CH)***

8.1 Adsorption theory
8.2 Granular activated carbon (GAC) adsorption systems
8.3 Powdered activated carbon (PAC) adsorption systems
8.4 Thermal reactivation of GAC
8.5 Adsorption of organic matter on resins
8.6 Other emerging materials

9. *Water Treatment Plant Residuals Management* ***(2CH)***

9.1 Quantity of residuals generated
9.2 Physical and chemical characteristics of residuals
9.3 Thickening of residuals
9.4 Recycle
9.5 Membrane and ion exchange residuals
9.6 Ultimate disposal and utilization of solids

10. *Laboratory Work* ***(15 CH)***

Laboratory activities will be an integral part of the course and will include instruction in the use of safety procedures, tools, equipment, materials, and processes to enhance hands-on experiences for students.

Learning Outcomes

On completing the course the student should be able to:

- Understand the basic principles of coagulation, flocculation, filtration and oxidation/ disinfection processes, and select appropriate processes depending on the nature of impurities to be removed and the intended use of the treated water;
- Comprehend the basic principles of advanced water treatment processes, capabilities/constraints of their application in water treatment and have knowledge on the design and operation of these processes;
- Select an appropriate treatment process for a specific application, and be able to identify appropriate pre-treatment and post treatment schemes, and cleaning protocols for these processes.

Mode of teaching/delivery

The course shall be conducted through lectures, tutorials and practicals (including excursions to two water supply facilities).

Mode of Assessment

Assessment will be done through continuous interim assessments (assignments, practicals and tests) and a final examination. Interim assessment will carry a total of 40% and final examination will carry 60% of the final grade mark.

Proposed Staff
Dr. Robinah Kulabako
Kalibbala Herbert Mpagi

Reading/Reference Materials

Water Treatment Plant Design, 4th edition, Baruth, Edward E. (editor) McGraw – Hill

Waterworks Engineering: Planning, Design and Operation by Syed R. Qasim, Edward M. Motley and Guang Zhu

6.1.7 CIV7117 Air and Noise Pollution (3 CU)

Course Description

With increasing noise and air pollution nationally and globally, it is necessary to be familiar with basic information regarding air and noise pollution to allow proper assessment of impacts arising from the various projects or activities and devising appropriate mitigation or control measures. In this respect, the Air and Noise Pollution course is subdivided into three sections: the general introductory, air pollution and noise pollution sections. The general introductory section covers information on national standards and regulations governing air and noise levels; definitions of air pollution and noise pollution. The air pollution section includes aspects on: sources, types and effects of air pollutants, air pollution sources; ambient air/ or and emission measurement and monitoring including sampling procedures; minimization and control of emissions; indoor air pollution and control. The noise pollution section covers sources, characteristics and effects of industrial, transportation and urban noise; measurement, assessment and evaluation of noise; control of noise and protection of recipients.

Objectives

The purpose of this course is to give the students an overview of air and noise pollution including methods for prevention, control, measures and management of the pollution.

Course Content

General Introduction ***(1CH)***

Air Pollution

1. ***Introduction*** ***(4CH)***

- 1.1 Sources of air pollution
- 1.2 Effects of air pollution
  - 1.2.1 Acid rain effects
  - 1.2.2 Losses in stratospheric ozone layer
  - 1.2.3 Global warming
- 1.3 Fate of air pollutants
- 1.4 Atmospheric Chemistry
  - 1.4.1 Basic chemical processes
  - 1.4.2 Particulates
  - 1.4.3 Long-Range Planning

2. ***Air Quality: Emission Measurement and Monitoring*** ***(5CH)***

2.1 Planning testing program
2.2 Sampling
  2.2.1 Sampling of ambient air
  2.2.2 Gas and Vapor Sampling
  2.2.3 Particulate Matter Sampling
2.3 Analyzing air emissions
2.4 Monitoring area emissions

3. *Minimization and Control of Emissions* ***(5CH)***
3.1 Pollution reduction
3.2 Particulate and gaseous emission control
3.4 Fugitive Emissions
3.5 Odour Control
  3.5.1 Perception, effect and characterization
  3.5.2 Odour control strategies

4. *Indoor Air Pollution: Sources, Effects and Control* ***(2CH)***
4.1 Radon
4.2 Other Indoor Pollutants
4.3 Air quality in the workplace

Noise Pollution

5. *Introduction: Sources and Effects of Noise* ***(2CH)***
5.1 Sources and typical range of noise levels
5.2 Characteristics of noise
  5.2.1 Industrial noise
  5.2.2 Transportation noise
  5.2.3 Urban noise
5.3 Specific noise sources
5.4 Effects of noise
  5.4.1 Reactions to noise
  5.4.2 Psychological effects
  5.4.3 Pollution

6. *Noise Measurement, Assessment and Evaluation* ***(5CH)***
6.1 Basic definitions and terminology
6.2 Frequency sensitivity and equal loudness characteristics
6.3 Vibration and vibration Measurement
6.4 Measuring Noise at workplace and community levels
6.5 Plant Noise Survey

7. *Noise Control and Protection of Receiver* ***(6CH)***
7.1 Noise control at the source
  7.1.1 Source-Path-Receiver Concept
  7.1.2 Control of Noise Source by Design
  7.1.3 Control of Noise Source by Redress
7.2 Noise control in the transmission path

7.2.1 Acoustical Separation
7.2.2 Physical Barriers
7.2.3 Isolators and Silencers

7.3 Protecting the receiver
7.3.1 Work Schedules
7.3.2 Equipment and Shelters

8. *Practical Work* *(15CH)*

Practical work will be part of the course and will include instruction in the use of noise measurements at various location, evaluation and proposing mitigation measures.

Learning Outcomes

On completing the course the student should be able to:

- Demonstrate understanding of the basic science of air and noise propagation including effects and damages that arise from air and noise pollution
- Advise on methods of air and noise reduction and sound insulation for a range of situations.

Mode of teaching/delivery

The course shall be conducted through lectures, tutorials and practicals.

Mode of Assessment

Assessment will be done through continuous interim assessments (assignments, practicals and tests) and a final examination. Interim assessment will carry a total of 40% and final examination will carry 60% of the final grade mark.

Proposed Staff

Dr. Robinah Kulabako
Kalibbala Herbert Mpagi

Reading/Reference Materials

Behar, A., Chasin, M. and Cheesman, M. (2000) Noise Control: A Primer. California: Singular Publishing Group.
Boubel, R.W., Fox, D.L., Turner, D.B. and Stern, A.C. Fundamental of Air Pollution, Third edition Academic Press
Cowan, J.P. (1994) Handbook of Environmental Acoustics. New York: Van Nostrand Reinhold.
Smith, B.J., Peters, R.J. and Owen, S. (2001) Acoustic and Noise Control. Second edition. Essex: Longman Group.
Turco, R.P. (1997) Earth under Siege: From Air Pollution to Global Change. New York: Oxford University Press.

6.1.8 CIV7118 Wastewater treatment and reuse (3 CU)

Course Description

This course provides the need for wastewater treatment, importance of understanding the different wastewater sources and characteristics as a means of identifying wastewater treatment processes and design of wastewater treatment plants. It introduces preliminary treatment unit processes, biological treatment systems, nutrient removal systems, wastewater treatment ponds, sludge characteristics, handling and treatment. In addition, reuse of treated wastewater is presented as a

waste management practice.

Objectives

- to create an understanding of unit processes and unit operations in wastewater treatment
- to spread knowledge on technologies and technology selection
- to enhance student's ability to design conventional wastewater treatment plants and other alternative wastewater treatment systems
- to provide an understanding of reuse of treated wastewater

Course Content

1. *Introduction* ***(2CH)***

1.1 Sources of wastewater
1.2 Need for wastewater treatment
1.3 Priorities in Environmental Engineering

2. *Characteristics of wastewater* ***(2CH)***

2.1 Introduction
2.2 Classification of solids
2.3 Organic matter
2.4 Nutrients N & P
2.5 Pathogens
2.6 Industrial wastewater

3. *Primary treatment* ***(3CH)***

3.1 Definitions and terms
3.2 Grit removal
3.3 Screens
3.4 Strainers
3.5 Sedimentation
3.6 Neutralisation
3.7 Equalisation
3.8 Dissolved Air Flotation

4. *Organic matter removal-Activated sludge treatment* ***(3CH)***

4.1 Introduction
4.2 Activated sludge system constraints
4.3 Model simplifications
4.4 Steady state system equations
4.5 System design and control parameters

5. *Nitrogen Removal* ***(4CH)***

5.1 Introduction to nitrification
5.2 Biological and Process kinetics
5.3 Factors influencing nitrification
5.4 Nutrient requirements for sludge production
5.5 Design considerations
5.6 Development and demonstration of design procedure
5.7 System design, operation and control

5.8 Innovative nitrogen removal

6. ***Phosphorus removal*** ***(4CH)***

6.1 Introduction
6.2 Principal of enhanced biological phosphorus removal (EBPR)
6.3 Mechanism, optimisation and development of EBPR systems
6.4 Factors influencing the magnitude of phosphorus removal
6.5 Conclusions and perspectives

7. Pathogen removal ***(2CH)***

7.1 Introduction
7.2 Types of enteric pathogens
7.3 Occurrence of pathogens in sewage
7.4 Removal of pathogens and indicators by wastewater treatment
7.5 Conclusions

8. ***Anaerobic wastewater treatment*** ***(3CH)***

8.1 Sustainability in wastewater treatment
8.2 Microbiology of anaerobic conversions
8.3 Anaerobic reactor systems
8.4 Upflow anaerobic sludge blanket (UASB) reactor
8.5 Anaerobic process kinetics
8.6 Anaerobic treatment of domestic and municipal sewage

9. ***Biofilm reactors*** ***(3CH)***

5.1Introduction and types of biofilm reactors
5.2 Design parameters and considerations
5.3 How to determine maximum design loading rates
5.4 Other design considerations

10. ***Sludge handling and treatment*** ***(2CH)***

Sludge characteristics
Pumping
Anaerobic digestion
Dewatering

11. ***Wastewater reuse*** ***(2CH)***

12. ***Field and Laboratory Work*** ***(15CH)***

Both laboratory and field activities will be an integral part of the course and will include instruction in the use of procedures, equipment, materials to enhance hands-on experiences and visits to at least two wastewater treatment facilities for exposure.

Learning Outcomes

On completing the course the student should be able to:

- § Understand the basic principles of primary treatment processes and select appropriate processes depending on the nature of impurities to be removed and the intended use of the treated wastewater;
- § Distinguish between unit processes and operations in wastewater treatment an appropriate wastewater treatment processes for a specific application, and be able to identify appropriate pre-treatment and post treatment schemes, and operation protocols for these processes.
- § Should be able to design biological systems in wastewater treatment
- § Understand the concepts of reuse and cost recovery in wastewater management

Mode of teaching/delivery

The course shall be conducted through lectures, tutorials and practicals (including excursions to two wastewater treatment facilities).

Mode of Assessment

Assessment will be done through continuous interim assessments (assignments, practicals and tests) and a final examination. Interim assessment will carry a total of 40% and final examination will carry 60% of the final grade mark.

Proposed Staff

Dr. Robinah Kulabako

Kalibbala Herbert Mpagi

Reading/Reference Materials

George Tchobanoglous, Franklin L. Burton, H. David Stensel (2003). *Wastewater engineering:treatment and reuse*, Metcalf & Eddy, Inc. Fourth Edition. McGraw-Hill series in civil and environmental engineering. ISBN 0-07-041878-0.

Mogens Henze, Mark C.M. van Loosdrecht, George A. Ekama, Damir Brdjanovic (editors) (2008). Biological wastewater treatment- Principles, Modelling and Design. IWA Publishing

6.1.9 CIV7119 Advanced Soil Mechanics (3 CU)

Course Description

This course is designed to give an advanced thorough theoretical background to the different aspects encountered in geotechnical design for example earth pressure analyses, bearing capacity theories, assessments of settlements and displacements and so on.

Objectives

- To introduce critical thinking in the analysis and design of geotechnical systems
- To lay a firm theoretical background necessary in the design of geotechnical systems
- To introduce the theory of stress path in the Geotechnical design

Course Content

1. *Shear Strength* ***(7CH)***

1.1 Review of shear strength under traditional triaxial compression

1.1.1 Effective and total stress shear strength

1.1.2 Drained and undrained shear strength

1.1.3 Back pressure saturation

1.2 Stress-strain behaviour of soil under traditional triaxial conditions
1.3 Mohr-Coloumb criterion as a serviceability criterion
1.3.1 Principal stress and Mohr circle by origin of planes and concept of pole points
1.3.2 Modified Mohr circle diagrams and the concept of the stress path both for drained and Undrained conditions
1.4 Stress-strain behaviour for non-traditional triaxial compression cases
1.4.1 Triaxial extension cases
1.5 Generalised drained conditions
1.5.1 Principal stress difference vs principal stress ratio as failure criterion
1.6 Generalised undrained conditions
1.6.1 pore pressure parameters A, B, D
1.6.2 Principal stress difference vs principal stress ratio as failure criterion
1.7 Rotation of principal planes
1.7.1 SHANSEP method for staged construction of embankments

2. *Stress conditions* ***(7CH)***

2.1 Generalised stability problems
2.2 Compatibility demands
2.2.1 Static compatibility
2.2.2 Kinematical compatibility
2.3 stress conditions on random planes
2.4 stress conditions on critical and arbitrary planes

3. *Stress fields* ***(7CH)***

3.1 effective stress analysis
3.1.1 Active and passive zones
3.1.2 Prandtl zones
3.2 Su-analysis
3.2.1 Rankine zones
3.2.2 Prandtl zones

4. *Stress fields and Earth pressures* ***(8CH)***

4.1 Active and passive earth pressures
4.2 Earth pressure equations-weightless soils
4.2.1 Combination of stress zones for earth pressure (drained consitions)
4.2.2 Combination of stress zones for earth pressure (undrained conditions)
4.3 Discussion of roughness ratio
4.4 Use of earth pressure diagrams

5. *Stress fields and Bearing Capacity* ***(8CH)***

5.1 Bearing capacity, weightless soil
5.1.1 Drained analysis both for vertical centric load and centric inclined load
5.1.2 Su-analysis both for vertical centric load and centric inclined load.
5.2 Soil density effects
5.3 Shape factors
5.4 Eccentic loads
5.5 Use of design charts

6. *Consolidation Theory* ***(8CH)***

6.1 Discussion of 1-D consolidation
  6.2.1 Stress-strain curves
  6.2.2 Secondary consolidation
6.2 Terzaghi theory of consolidation
  6.2.1 Extension to non-rectangular surfaces
  6.2.2 Superposition applied to complex surfaces
6.3 Consolidation for multi-layered compressible soil profiles and partial draining surfaces
6.4 Time-dependent loading
6.5 Finite difference formulations.

Learning Outcomes

On completing the course the student should be able to:

- Determine the appropriate type of soil shear strength to be used for analysis and design of geotechnical structures (e.g slope, foundations, earth retaining structures etc.)
- Evaluate effects of submergence, partial draining boundaries, time-dependent loading and radial drainage on the consolidation properties of soil as well as time-rates of consolidation of compressible soils for a variety of engineering problems

Mode of teaching/delivery

The course shall be conducted through lectures and tutorials

Mode of Assessment

Assessment will be done through continuous interim assessments (assignments and tests) and a final examination. Interim assessment will carry a total of 40% and final examination will carry 60% of the final grade mark.

Proposed Staff

Dr. Dennis Kalumba
Gilbert Kasangaki
Richard Kizza

Reading material / References

Lambe and Whitman: *Soil mechanics*, John Wiley and Sons Inc., 1969

Muni Budhu : *Soil Mechanics and Foundations, 2nd Ed*. John Wiley and Sons Inc., 2007

Terzaghi.K, Peck.R.B and Mesri.G: *Soil Mechanics in Engineering Practice, 3rd Ed.* John Willey and Sons Inc.,1996

6.1.10 CIV7120 Advanced Foundation Engineering (3 CU)

Course Description

This course aims at cultivating higher level insights in theories for foundation engineering and to promote critical thinking in designing and analyzing foundations. The course will cover classical and modern topics of foundation engineering for example dynamic pile driving equations.

Course Objectives

- To equip participants with information needed to design foundations at the state of the art. Participants will be equipped with abilities to evaluate bearing capacity and settlement

failure conditions for shallow and deep foundations. Finite Element tools will be discussed as well as conventional design tools.

- To equip participants with modern instrumentation for foundation design and correct selection of soil parameters for foundation design
- To enable participants select the best foundation solutions for different types of Civil Engineering problems

Course Content

1. ***Introduction*** ***(4CH)***
1.1 Review of Soil Mechanics
. 1.2 Elastic Settlements
1.3 Consolidation Analysis

2. ***Site Investigations and Foundation types*** ***(3CH)***

3. ***Bearing Capacity theories*** ***(4CH)***

4. ***Design of Shallow foundation systems*** ***(8CH)***

5. ***Design of Piles*** ***(8CH)***
5.1 Design of Single Pile Systems
5.2 Design of pile groups

6. ***Pile Installation*** ***(6CH)***
6.1 Pile Driving equations
6.2 Wave equations
6.3 selection of hammer
6.4 Pile load tests

7. ***Design of Deep Foundations under lateral loads*** ***(4CH)***

8. ***Design and Analysis of the micropile*** ***(4CH)***

9. ***Drilled Piers*** ***(4CH)***
9.1 Design
9.2 Inspection

Learning Outcomes

On completing the course the student should be able to:

- § Design and analyse foundation systems using conventional methods
- § Design a budget and proposal for a Geotechnical investigation
- § Design appropriate foundation systems based on ground-investigation data and be able to select correct soil parameters for the designs
- § Select boring depth , location and associated laboratory tests for simple construction projects

Mode of teaching/delivery

The course shall be conducted through lectures, tutorials and practicals.

Mode of Assessment

Assessment will be done through continuous interim assessments (assignments and tests) and a final examination. Interim assessment will carry a total of 40% and final examination will carry 60% of the final grade mark.

Proposed Staff

Dr. Denis Kalumba
Gilbert Kasangaki
Richard Kizza

Reading material / References

Bowles, J.E: *Foundation Analysis and design*, *4th Ed.* Mac.Graw-Hill, 1988

Braja. M. Das: *Principles of Foundation Engineering, 6th Ed.* McGraw-Hill*, 2003*

Muni Budhu : *Soil Mechanics and Foundations, 2nd Ed*. John Wiley and Sons Inc., 2007

Reese L.C , Isenhover W.M., Wang S.T : *Analysis and Design of Shallow and Deep foundations,* Wiley, *2006.*

6.1.11 CIV7121 Static and dynamic Soil-Structure Interaction (3 CU)

Course Description

The course introduces to the participants the theory of soil structure interaction (SSI) both in the static and dynamic sense. The course will expose the participants to the numerical tools available for modelling such problems. It will include both theoretical lectures and hands-on solutions of practical problems using Matlab.

Objectives

- To introduce the participants to theory and need for SSI in engineering designs.
- To introduce the participants to the available tools for conducting SSI

Course Content

1.	***Review of basic vibration dynamic theory***	***(3CH)***
2.	***Simple interaction problems for footings and piles in homogenous half space***	***(4CH)***
3.	***Harmonic analysis***	***(4CH)***
4.	***Radiating criterion and transmitting boundaries***	***(5CH)***
5.	***Applications to planar and axissymetric problems of footings, piles and dams***	***(5CH)***
6.	***Spectral elements and transfer matrix methods***	***(5CH)***
7.	***Applications to stress waves in inhomogeneous media***	***(5CH)***
8.	***Boundary element methods***	***(5CH)***
9.	***Soil-foundation-superstructure interaction under seismic loading***	***(5CH)***
10.	***Application examples***	***(4CH)***

Learning Outcomes

On completing the course the student should be able to:

- § Include Soil-structure interaction aspects in design
- § Assess the need for SSI in the different design works where it maybe needed
- § Use the available numerical tools for SSI

Mode of teaching/delivery

The course shall be conducted through lectures, tutorials and computer sessions

Mode of Assessment

Assessment will be done through continuous interim assessments (assignments and tests) and a final examination. Interim assessment will carry a total of 40% and final examination will carry 60% of the final grade mark.

Proposed Staff

Dr. Denis Kalumba

Gilbert Kasangaki

Reading material / References

Wolf (1985): *Dynamic Soil structure interaction*. Prentice Hall

Wolf. JP, Deeks AJ (2004): *Foundation Vibration Analysis: a Strength Materials Approach*, Butterworth-Heinemann

6.1.12 CIV7113 Water Resources Management (3 CU)

Course Description

This course is intended to introduce students to the planning and management of water resources projects with case studies and the policy and institutional framework of the water sector in Uganda and other countries. It will also look at integrated water resources management, catchment management in addition to the management of extreme events like floods, droughts and climate change.

Objectives

To learn about planning of water resources projects including environmental impacts

To learn about the policy, legal and institutional framework in the water sector

To learn about integrated water resource management and catchment management

To learn about the management of extreme events like floods, droughts and climate change

Course Content

1. *Water Resources Planning* ***(6CH)***

1.1 Worldwide Issues

1.2 Case Studies

1.3 Project Planning

1.4 Environmental Impacts

2. *Systems Modelling* ***(6CH)***

Functions of the Water Resource System

Evaluation of Alternatives
Performance Criteria

3. *Water Resources in Uganda* ***(6CH)***
- 3.1 Policy, Legal and Institutional Framework
- 3.2 Programmes and Initiatives
- 3.3 Issues

4. *Rural Water and Sanitation* ***(6CH)***
- 4.1 Policy, Legal and Institutional Framework
- 4.2 Programmes and Initiatives
- 4.3 Issues

5. *Urban Water and Sanitation* ***(3CH)***
- 5.1 Policy, Legal and Institutional Framework
- 5.2 Programmes and Initiatives
- 5.3 Issues

6. *Integrated Water Resource Management* ***(6CH)***

Planning
Institutional Framework
Case Studies

7. *Catchment Management* ***(3CH)***
- 7.1 Planning
- 7.2 Institutional Framework
- 7.3 Case Studies

8. *Extreme Events Management* ***(9CH)***
- 8.1 Droughts causes, impacts and mitigation
- 8.2 Floods impacts and mitigation
- 8.3 Climate change, impacts and mitigation

Learning Outcomes

- § To plan water resources projects and consider environmental effects
- § To understand the importance of a policy, legal and institutional framework in water management.
- § To understand integrated water resource management and catchment management
- § To understand how floods, droughts and climate change can be mitigated

Mode of Delivery

The mode of delivery is through lectures and tutorials.

Mode of Assessment

Assessment will be done through continuous interim assessments (assignments, practicals and tests) and a final examination. Interim assessment will carry a total of 40% and final examination will carry 60% of the final grade mark.

Proposed Staff

Dr. Albert Rugumayo

References

Mansell, M.G. *Rural and Urban Hydrology*, Thomas Telford, 2003, London, UK

Subramanya, K., *Engineering Hydrology*, 2nd Edition 2001,Tata McGraw Hill, New Dehli, India.

Wilson, E.M., *Engineering Hydrology*, 4th Edition, Macmillan,1996, London, UK.

Duggal, K.N., Soni, J.P., *Elements of Water Resources Engineering*, New Age Publishers, 2007, Dehli, India.

Singh, V. P. *Hydrologic Systems*, Prentice-Hall Englewood Cliffs,1989 New Jersey, USA

Rugumayo, A.I., Lecture Notes, *An Introduction to Hydrology and Water Resources Engineering, Lecture Notes*, Kampala, 2010

Loucks, D.P., van Beek, E., *Water Resources Systems Planning and Management An Introduction to Methods Models and Applications*, UNESCO 2005,Paris

Thanh, N.C., Biswas, A.K., Ed. *Environmentally Sound Water Management*, Oxford University Press, 1990, Oxford, UK.

Tucci, C.E.M., *Urban Flood Management*, the World Meteorological Organization and Cap-Net International Network for Capacity Building in Integrated Water Resources Management, 2007,Geneva, Switzerland.

Linsely R.K., Franzini J.B., *Water Resources Engineering*, McGraw Hill, 1979, New York, USA.
Fresh Water Resources, Agenda 21 Chapter 18, United Nations Commission on Economics and Development (UNCED) Process, 1992, Dublin and Rio de Janerio.

Jonch-Clausen, T. *Integrated Water Resources Management (IWRM) and Water Efficiency Plans by 2005, Why, What and How*? Global Water Partnership, 2004, Stockholm, Sweden.

Cosgrove W.J., Rijsberman F.R., World Water Vision, Earthscan Publications Ltd, 2000, London, UK.

Shiklomanov, I.A., World Water Resources, A New appraisal and Assessment for the 20th Century, 1998, UNESCO, Paris, France.

Otter, L., Olago, D.O., Niang, I., Ed. Global Change Process and Impacts in Africa: A Synthesis, 2009, East African Educational Publishers, Nairobi, Kenya and START, Washington DC, USA.

6.1.13 CIV7114 Advanced Surface Hydrology (3 CU)

Course Description

The net rainfall over a river basin will produce the storm runoff hydrograph. As the storm runoff is generated from different locations within the basin, a time distribution of the storm runoff with time will be observed. To calculate the storm hydrograph in a location along the river, it is necessary to account for the transport of the water from within the river basin towards this location. Although the transport mechanisms may be complex and consist of flow over the surface, flow within ditches and rivers and subsurface storm flow, this transport is here referred to as surface runoff and this course mainly deals with the processes described above.

Objectives

The course is intended to provide the student with:

- Hydraulic methods
- Linear models such as the unit hydrograph and linear reservoir models
- Non- linear hydrologic methods

Course Content

1. *Introduction and Definitions* *(4CH)*

2. *Hydrodynamics methods* *(4CH)*

3. *The General Hydrologic System* *(14CH)*

3.1 The general hydrologic system model

3.2 Linear time invariant systems

4. *Response Functions of Linear Systems* *(6CH)*

The impulse response function

The step response function

The impulse response function

5. *The Unit Hydrograph* *(6CH)*

Introduction

Convolution

De-convolution

Standard unit hydrographs

The time-area method

6. *Linear Reservoir Models* *(6CH)*

Introduction

The single linear reservoir

Reservoirs in series

The linear channel

7. *Non-Linear Reservoir Models* *(5CH)*

Learning Outcomes

On completing the course the student should be able to:

- § Apply various hydrological principles in the analysis of surface water resources problems
- § Employ hydrological models for surface water simulation
- § Have practical experience in modelling and model assessment

Mode of teaching/delivery

The course shall be conducted through Lectures, Tutorials and Practical Computer simulations.

Mode of Assessment

Assessment will be done through continuous interim assessments (assignments and tests) and a final examination. Interim assessment will carry a total of 40% and final examination will carry 60% of the final grade mark.

Proposed Staff

Dr. Max Kigobe

Dr. Albert I. Rugumayo

Reading/Reference Materials

Chow, V.T., D.R. Maidment & L.W. Mays (1988). *Applied hydrology*, McGraw Hill, New York

Desbordes, M. (1978). *Urban runoff and design storm modelling*, Proc. Int. Conf. on Urban Storm Drainage, Southampton, p. 353-361.

McCuen, R.H., S.L. Wong & W.J. Rawls (1984). *Estimating urban time of concentration*, J. of Hyd. Eng., A.S.C.E., Vol. 110, No. 7, pp. 887-904.

Radojkovic M. & C. Maksimovic (1987). *On standardization of computational models for overland flow*, Proc. Int. Conf. on Urban Storm Drainage, Topics in Urban Drainage Hydraulics and Hydrology, Lausanne.

Viessmann, W. (1968). *Runoff estimation for very small drainage areas*, Water Res. Res., Vol. 4, No. 1, pp. 87,.
Viessman, W., J.W. Knapp, G.L. Lewis & T.E. Harbaugh (1977). *Introduction to hydrology*, Harper Row, New York)

6.1.14 CIV7124 Statistical Analysis in Hydrology (3 CU)

Course Description
The course provides fundamental knowledge and practical understanding for the common statistical techniques of data processing in hydrology and water engineering. This knowledge and understanding must allow the students to select and apply most appropriate techniques to summarize and organize data. It also allows them to have an insight in the limitations of data collection, and the corresponding consequences for water management and engineering.

Objectives
The course is intended to provide the student with:

- An understanding of the application of statistical analysis in earth sciences
- Experience on the use of probability distributions and statistical theory/methods in solving water resources problems
- Experience on the use of modern statistical methods in problem solving

Course Content

1. ***Basic concepts of probability and probability distributions*** ***(4CH)***
2. ***Properties of random variables*** ***(4CH)***
3. ***Discrete probability distributions*** ***(5CH)***
4. ***Normal distribution and other continuous distributions*** ***(6CH)***
5. ***Frequency analysis*** ***(5CH)***
6. ***Confidence interval and hypothesis testing*** ***(5CH)***
7. ***Goodness-of-fit test*** ***(5CH)***
8. ***Simple and multiple regression*** ***(5CH)***
9. ***Time series analysis*** ***(6CH)***

Learning Outcomes
On completing the course the student should be able to:

§ Apply various statistical techniques for the analysis of water resources problems
§ Employ statistical tools for hydrological modelling and model assessment

Mode of teaching/delivery
The course shall be conducted through lectures, tutorials.

Mode of Assessment

Assessment will be done through continuous interim assessments (assignments and tests) and a final examination. Interim assessment will carry a total of 40% and final examination will carry 60% of the final grade mark.

Proposed Staff

Mr. Michael Kizza
Dr. Albert I. Rugumayo

Reading/Reference Materials

Statistical Methods in Hydrology, by Charles T. Haan

Stochastic and Statistical Methods in Hydrology and Environmental Engineering: Time Series Analysis in Hydrology and Environmental Engineering by Keith W. Hipel, A. Ian McLeod, U. S. Panu, V. P. Singh. Kluwer Academic (1994)

Flood frequency analysis, by Adiseshappa Ramachandra Rao, Khaled H. Hamed, CRC Press (2000)

6.1.15 CIV7112 Highway Geometric Design (3 CU)

Course Description

This course will provide students with an understanding of the fundamental principles and techniques of design of geometric features of a highway. This will include laying out potential routes, design of the alignment and intersections, and evaluation of earthwork requirements.

Objectives

- To introduce basic elements of traffic engineering; traffic studies and characteristics, facility design and traffic control.
- To explain the importance and steps of highway geometry design in relation to safety and operation.
- Explain the importance of key design elements and design factors in relation to safety and operation.

Course Content

1. *Preliminary Selection of Route ways* ***(6CH)***

Selection factors
Roadway surveys
Preliminary investigations
Principles of alignment

2. *Earthwork computations* ***(7CH)***

Plant and equipment
Volume computations
Costing of quantities

3. *Geometric configuration of streets, expressways, bus ways to meet the characteristics of vehicle performance and operator limitations* ***(8CH)***

Flow, speed and density

Speed flow curves
Speed, travel time and delay studies
Spot speeds

4. *Alignment design* ***(7CH)***

Volume and rate of flow
- Spacing, density and headway
- Design factors
- Super elevations
- Sight distances

5. *Intersections, interchanges and parking facilities* ***(7CH)***

Volume studies and characteristics
- Traffic counts at various facilities
- Delays
- Future traffic prediction
- Signalization

6. *Level of service concept, roadside and guardrail design* ***(6CH)***

Fundamental aspects

7. *Application of road design software.* ***(4CH)***

Introduction to software
Working exercises

Learning Outcomes

At the end of this course, a student should be able to:
- § Understand and apply the principles learnt to highway design problems.
- § Use existing computer tools to generate and analyze designs.
- § Work independently in the field of highway design.

Mode of teaching/delivery

The teaching of students will be conducted through lectures, tutorials, short classroom exercises, case studies, group discussions among the students and projects aimed at solving real life problems. The lecture material will be availed to the students in advance to enable them have prior reading. Solving real life problems in each theme or a number of topics will enhance the students' understanding of the problem based learning techniques.

Assessment Method

Assessment will be done through coursework which will include assignments, class room and take home tests, project work and presentations and a written examination. Course work will carry a total of 40% and written examination carries 60%. Coursework marks will be divided into; Assignments 5%, Tests 10% and Practical Work 25%.

Proposed Staff

Dr. Umaru Bagampadde
Godfrey Mwesige

Reading/Reference Materials

Transportation Research Board (2000), *Highway Capacity Manual 2000.*

Ministry of Works, Transport and Communications, Republic of Uganda, Road Design Manual, November 1994.

MoWHC Uganda, Road Design Manual, Road Safety Revision, July 2004.

A policy on Geometric Design of Highway and Street, American Association of State Highway and Transportation Officials (AASHTO) 1994.

Road design Manual, Part 1, Geometric Design of Rural Roads, Republic of Kenya Ministry of Works January 1979.

Geometric design manual, Federal Republic of Ethiopia, Ethiopian Roads Authority, 2001.

South Africa Geometric Design Guidelines, 2003.

MoWHC, Republic of Uganda, *Traffic Signs Manual* (Draft 2004).

MOWHC (2005), *Geometric Design Manual, Section 6*

6.1.16 CIV7122 Transport Systems Analysis (3 CU)

Course Description

This course covers a multidisciplinary field which draws on engineering, economics, operations research, political science, psychology, management, and other disciplines. The course synthesizes from these fields an approach that is intellectually coherent and comprehensive in assessing the interaction between transportation facilities and the social economic system of an area through prediction of traffic flows.

Objectives

The aims of this course are to:

- Identify concepts that are fundamental to serious work in the planning, design, or management of transportation systems,
- Detailed treatment of transportation system demand and supply,
- Undertake evaluation and choice modelling.

Course Content

1. ***Application of systems approach to transportation*** ***(7CH)***

   The challenge of transportation
   The transportation system
   System options
   Consequences of transportation - impacts

2. ***Determination of transportation demand and supply*** ***(8CH)***

   Prediction of flows
   Other elements of prediction
   Human behavior – Individual and Aggregate
   Behavioral models

3. ***The equilibrium process*** ***(8CH)***

Service and demand functions

Flow patterns
System models

4. *Transportation system evaluation* ***(8CH)***

Disaggregate prediction of behavior
Variations in Level of Service
Aggregate prediction of behavior
Elasticity of demand

5. *Cost-effectiveness techniques* ***(8CH)***

Benefit Costs Analysis
The time dimension
Capital recovery factor
Equivalent annual cost method
Net present value method

6. *Use of optimization techniques in transportation* ***(6CH)***

Minimization/Maximization methods
Practical examples

Learning Outcomes

At the end of this course, a student should be able to:

- § Apply the systems approach to transportation.
- § Determine the demand for transportation systems.
- § Apply prediction models for mode selection.

Mode of teaching/delivery

The teaching of students will be conducted through lectures, tutorials, short classroom exercises, case studies, group discussions among the students and projects aimed at solving real life problems. The lecture material will be availed to the students in advance to enable them have prior reading. Solving real life problems in each theme or a number of topics will enhance the students' understanding of the problem based learning techniques.

Mode of Assessment

Assessment will be done through coursework which will include assignments, class room and take home tests, project work and presentations and a written examination. Course work will carry a total of 40% and written examination carries 60%. Coursework marks will be divided into; Assignments 5%, Tests 10% and Practical Work 25%.

Proposed Staff

Dr. Umaru Bagampadde
Godfrey Mwesige

Reading/Reference Materials

M L Manheim. *Fundamentals of transportation systems analysis Vol.1*. MIT Press, 1978.

6.1.17 CIV7123 Airport Design (3 CU)

Course Description

This course covers the aspects of design and construction of civil airport facilities including access, terminal building (passenger and cargo handling) and airside infrastructure.

Objectives

The aims of this course are to:

- Plan for airport activities in the short and long term,
- Design airport physical facilities,
- Assess impacts of airport operations to the environment.

Course Content

1. *Planning and design of airport facilities* ***(5CH)***

Aviation systems planning
Levels of planning
Structures of air transport service
Airport system planning
Airport master planning

2. *Aircraft geometric and operational characteristics* ***(5CH)***

2.1 Airports and aircrafts
2.2 Aircraft design and runways
2.3 Aircraft characteristics
2.4 Weights and regulations
2.5 Noise
2.6 Future Trends

3. *Passenger demand analysis* ***(6CH)***

Demand forecasting methods
Trip generation and distribution models
Mode choice models

4. *Air-traffic control procedures* ***(7CH)***

4.1 Purpose of control
4.2 Flight rule and regulations
4.3 Airspace control
4.4 Navigation aids
4.5 Control facilities
4.6 Airport lighting
4.7 Airport marking
4.8 Docking systems

5. *Geometric design of runways and taxiways* ***(7CH)***

5.1 Runway and taxiway lengths
5.2 Clearways and stop ways
5.3 Separation of runways
5.4 Runway and taxiway cross section
5.5 Longitudinal grade design
5.6 Configuration and orientation

6. *Terminal design* *(6CH)*

Terminal facilities
Passenger and baggage flow/handling
Security
Design concepts

7. *Airport capacity* *(6CH)*

Capacity, demand and delay
Capacity factors
Demand factors
Delay factors
Queueing theory
Runway capacity

8. *Environmental impact of airports* *(3CH)*

Legislation
Airport noise
Land use impacts
Air and water pollution
Hydrologic and ecological impacts

Learning Outcomes

At the end of this course, a student should be able to:

- § Plan for airport operations.
- § Evaluate and design airport facilities.
- § Study whether operations of an airport significantly affect the nearby environs.

Mode of teaching/delivery

The teaching of students will be conducted through lectures, classroom exercises, term projects aimed at solving real life problems and group discussions among the students. The lecture material will be availed to the students in advance to enable them have prior reading. Solving real life problems in each theme or a number of topics will enhance the students' understanding of the problem based learning techniques.

Mode of Assessment

Assessment will be done through coursework which will include assignments, class room and take home tests, project work and presentations and a written examination. Course work will carry a total of 40% and written examination carries 60%.

Proposed Staff

Dr. Umaru Bagampadde

Reading/Reference Materials

Ashford N. and Wright P. H., *Airport Engineering*, John Wiley and Sons Inc., 2nd ed., 1992.

6.2 Semester II

6.2.1 EMT7201 Advanced Engineering Mathematics (3 CU)

Course Description

The course gives the background for simple analytical derivation and numerical calculations for stochastic processes in discrete and continuous time as well as the application of Finite Element Methods to the solution of partial Differential Equations arising from Structural Engineering, Heat Conductions, Geomatic Engineering and Electrical Transmission Lines and using appropriate software tools e.g. MATLAB. Topics include Finite Element Discretization and the Direct Stiffness Method, Mathematical Formulation of Finite Elements, Computer Implementation of Finite Elements, Stochastic (Random) Processes and Estimation Theory.

Objectives

The objectives are to develop a fundamental understanding of state-of-the-art finite element formulations and procedures, to develop an appreciation for the strengths and limitations of modern finite element methods and related software, to reinforce knowledge in solid mechanics with particular emphasis on nonlinear and dynamic problems, and to learn to utilize finite element methods as a research tool. Topics include finite element fundamentals and Weighted residual and finite element methods for the solution of hyperbolic, parabolic and elliptical partial differential equations, with application to problems in science and engineering. Error estimates. Standard and discontinuous Galerkin methods

The course gives the background for simple analytical derivation and numerical calculations for stochastic processes in discrete and continuous time as well as Estimation Theory

Learning Outcomes

Students should be proficient in basics of Finite Elements Methods, Properties and Classification of Stochastic Processes, associated mathematically rigorous proofs, and some programming language.

The Students should be able to articulate the Properties of classical Stochastic Processes and how these are applied in the classification of the same.

Mode of teaching/delivery

The teaching of students will be conducted through lectures, tutorials, short classroom exercises, case studies, group discussions among the students and projects aimed at solving real life problems. The lecture material will be availed to the students in advance to enable them have prior reading. Solving real life problems in each theme or a number of topics will enhance the students' understanding of the problem based learning techniques.

Method of Assessment

Assessment will be done through coursework which will include assignments, class room and take home tests, project work and presentations and a written examination. Course work will carry a total of 40% and written examination carries 60%. Coursework marks will be divided into; Assignments 5%, Tests 10% and Practical/project Work 25%.

Course Content

1 Finite Element Methods

1.1 ***Finite Element Discretization and the Direct Stiffness Method*** ***(6CH)***

- The Direct Stiffness
- Finite Element Modeling: Mesh, Loads, BCs

- Multifreedom Constraints
- Superelements and Global-Local Analysis

1.2 *Mathematical Formulation of Finite Elements* ***(12CH)***

- Variational Formulation of Bar Element
- Variational Formulation of Plane Beam Element
- Advanced One-Dimensional Elements
- The Plane Stress Problem
- Three-Node Plane Stress Triangles
- The Isoparametric Representation
- Isoparametric Quadrilaterals
- Shape Function Magic
- FEM Convergence Requirements

1.3 *Computer Implementation of Finite Elements* ***(12 CH)***

- Implementation of One-Dimensional Elements
- FEM Program for Space Trusses
- FEM Programs for Trusses and Frames
- Implementation of iso-P Quadrilateral Elements
- Implementation of iso-P Triangular Elements
- The Assembly Process
- Solving FEM Equations
- A Complete Plane Stress FEM Program
- Stress Recovery
- Fitting Fields Over
- Thermomechanical Effects

2 Stochastic (Random) Processes ***(9CH)***

- Definition
- Characterization: Probabilistic Description, Expected Values and Autocovariance Functions
- Classification: Stationary, Wide-Sense Stationary, Ergodic, Markov, Normal and Poisson Processes
- Analysis and Processing of Stochastic Processes: Spectral Density, and Response of Linear Systems to Random Input

3 Estimation Theory ***(6CH)***

- Definitions: Estimators, Point-Estimators, Interval Estimators
- Properties of Point Estimators
- Types of Estimation: Estimation of a Distribution's Unknown Parameter; Estimating the value of an inaccessible variable in terms of an accessible variable
- Maximum Likelihood Estimator
- Bayesian Estimator
- Mean Square Linear Estimator: Univariate Linear Regression; Orthogonality; Basic extension to Multivariate Linear Regression

Reading/Reference Materials

Hwei Hsu. *Probability, Random Variables & Random Processes*. Schaum's Outlines. ISBN 0-07-030644-3

Carl W. Helstrom, 1984. *Probability and Stochastic Processes for Engineers*. Macmillan Publishing Company, USA. ISBN 0-02-353560-1

Papoulis. *Probability, Random Variables & Stochastic Processes*, 3rd Edition., McGraw Hill.

Michel K. Ochi, 1990. *Applied Probability and Stochastic Processes in Engineering and Physical Sciences*. John Wiley & Sons, Inc. USA. ISBN 0-471-85742-4

George R. Cooper, and Clare D. McGillem, 1999. *Probabilistic Methods of Signal and Systems Analysis*. 3rd Edition. Oxford University Press, Newyork, USA. ISBN 0-19-512354-9

Yannis Viniotis. *Probability & Random Processes for Electrical Engineers*,McGraw Hill.

Jorge I Aunon, V. Chandrasekar. *Introduction to Probability & Random Processes*, McGraw Hill

Venkatarama Krishnan, 2006. *Probability and Random Processes* (Wiley Survival Guides in Engineering and Science), Wiley-Interscience; 1 Edition. ISBN-10: 0471703540, ISBN-13: 978-0471703549

Donald G. Childers, 1997. *Probability and Random Processes: Using Matlab with Applications to Continuous and Discrete Time Systems*. Richard D Irwin. ISBN-10: 0256133611, ISBN-13: 978-0256133615

Leon Garcia, 1993. *Probability and Random Processes for Electrical Engineering*. Addison Wesley Publishing Company; 2 Sol Edition. ISBN-10: 020155738X, ISBN-13: 978-0201557381

Roy D. Yates, David J. Goodman, 2004. *Probability and Stochastic Processes: A Friendly Introduction for Electrical and Computer Engineers*. Wiley; 2nd Edition. ISBN-10: 0471272140, ISBN-13: 978-0471272144

Paul M. Kurowski , 2004. *Finite Element Analysis For Design Engineers*. SAE International, ISBN-10: 9780768011401, ISBN-13: 978-0768011401, ASIN: 076801140X

Young W. Kwon), Hyochoong Bang, 2000. *The Finite Element Method Using MATLAB*, Second Edition. CRC Press. ISBN-10: 0849300967, ISBN-13: 978-0849300967

M. Asghar Bhatti, 2004. *Fundamental Finite Element Analysis and Applications: with Mathematica and Matlab Computations*. Wiley; 1st Edition. ISBN-10: 9780471648086, ISBN-13: 978-0471648086, ASIN: 0471648086

6.2.2 MEC7203 Project Management (3 CU)

Course Description

An overview of the theory and practice of managing projects in any organization, applying widely used software tools for project management and risk analysis. Emphasis is on leadership in project management: managing projects or tasks in a team environment; building teams; and utilizing communication, organization and conflict management skills. Discussion covers the various

phases of a project, including initiating, planning, executing, monitoring and controlling, and closing the project. Topics include analytical approaches and quantitative methods in project management, such as earned value management and techniques for estimating project duration and cost, optimizing allocation of resources, expediting projects and scheduling algorithms. Simulation tools and statistical techniques are used to analyze uncertainty in project selection, budget allocation and time estimation. Project management knowledge areas are examined and linked to industry practices for successful management of projects.

Objectives

The aims of this course are to:

- Enable students appreciate the role of projects in any industrial setting.
- Give students and understanding of the conduct of projects in all its various aspects such as project planning and management, tendering and procurement.

Course Content

1 *Foundations of Project Management* *(3CH)*

An overview of the theory and practice of managing projects in any organization. Emphasis is on leadership in project management: managing projects or tasks in a team environment; building teams; and utilizing communication, organization and conflict management skills. Discussion covers the various phases of a project, including initiating, planning, executing, monitoring and controlling, and closing the project. Project management knowledge areas are examined and linked to industry practices for successful management of projects. The goal is to gain a solid understanding of how to successfully manage each phase of the project life cycle, work within organizational constraints, set goals linked directly to stakeholder needs and utilize proven project management tools to complete projects on time and within budget while meeting specifications. Essential concepts, processes and techniques are applied through management of a team project, which requires regular progress reports and reviews.

2 *Project Risk Management* *(6CH)*

An in-depth analysis of risk management methodologies, from both strategic and tactical perspectives. State-of-the art tools and techniques for identifying, measuring and monitoring risks in the project management environment are examined. Both qualitative and quantitative risk analyses are conducted, and strategies for proactive risk aversion and reactive risk response are developed. Focus is on how a comprehensive risk management approach can enable a project team to proactively manage issues that adversely impact the successful control and completion of a project.

3 *Project Communications Management* *(3CH)*

An overview of conflict resolution processes and methods and the skills needed to manage the human elements within project management—a task as challenging as managing the technical aspects. Topics include critical communication and conflict resolution issues faced by project workers in today's global corporate environment. Innovative approaches to successfully negotiating and resolving conflicts among team members, colleagues, managers and stakeholders are introduced and practiced. Proven techniques to make conflict a constructive—rather than a destructive—experience are analyzed. Emphasis is on case study analysis, effective communication behaviors, negotiation skills and virtual team processes to successfully lead both

domestic and global projects.

4 *Project Quality Management* *(9CH)*

A study of the policy, processes and procedures involved in assuring that projects will satisfy the objectives for which they were undertaken. Emphasis is on quality planning, quality assurance, quality control, and process improvement. Discussion covers all the activities that determine quality objectives, policies, and responsibilities. The importance of customer satisfaction, prevention over inspection, management responsibility and continuous improvement is recognized. Topics include control charts, cause and effect diagrams, Pareto charts, failure mode and effect analysis, design reviews and cost of quality. Course content and approach are compatible with the International Organization for Standardization.

5 *Project Procurement Management* *(6CH)*

An examination of the tools needed for project procurement management. Focus is on determining what needs to be purchased or acquired and determining when and how to acquire it. Topics include planning the contracting efforts (documenting products and services and identifying potential sellers); requesting sellers' responses (obtaining information, quotation, bids, offers or proposals); selecting the seller (receiving and reviewing offers, selecting among those potential offers and negotiating a contract); administering contracts (managing the relationship between buyers and sellers, including documentation, corrective actions and contract changes); and closing contracts (completing the contract and settling all open issues).

6 *Financial Strategic Management and Projects* *(9CH)*

Financial and strategy making in project management. Covers: project cost estimation developed from work breakdown structure; formulating, monitoring and controlling project budgets; impact of project scope and schedule; managing project changes; management reserves to cover risks and contingencies; top-down and bottom-up budgeting; Earned Value Management as a key tool to monitor, evaluate and forecast project costs, schedule, results and performance; deriving project cash flows; investment project evaluation; discounted cash flow, internal rate of return and net present value methodologies; cost of capital; and capital budgeting. Broader issues examined include links between project and corporate financial performance, business ethics, corporate social responsibility, project and organizational culture issues, communications and information flow, financial risk analysis and project sustainability, for government as well as privately funded projects.

7 *Advanced Project Methods* *(9CH)*

An overview of advanced methods of managing projects, applying widely used software tools for project management and risk analysis. Topics include analytical approaches and quantitative methods in project management, such as earned value management and techniques for estimating project duration and cost, optimizing allocation of resources, expediting projects and scheduling algorithms. Simulation tools and statistical techniques are used to analyze uncertainty in project selection, budget allocation and time estimation. Discussion covers project portfolio management and how multiple projects and programs fit into strategic direction of an organization. The processes, tools and techniques of project management are applied to a team project with emphasis on quantitative and analytical methods.

Learning Outcomes

At the end of this course, a student should be able to:

- § Distinguish between a programme, project and a routine activity
- § Demonstrate knowledge and skills of processes, techniques, standards, empirical guidelines, computer software, team building used in project
- § Develop project requirements especially human and financial
- § Explain the various project monitoring and control techniques

Methods of teaching /delivery

The teaching of students will be conducted through lectures, tutorials, short classroom exercises, case studies, group discussions among the students and projects aimed at solving real life problems. The lecture material will be availed to the students in advance to enable them have prior reading. Solving real life problems in each theme or a number of topics will enhance the students' understanding of the problem based learning techniques.

Method of Assessment

Assessment will be done through coursework which will include assignments, class room and take home tests, project work and presentations and a written examination. Course work will carry a total of 40% and written examination carries 60%. Coursework marks will be divided into; Assignments 5%, Tests 10% and Project Work 25%.

Reading/Reference Materials

Meredith, J.R. and Mantel, S.J. 2009*, Project management: a managerial approach*. 7th edition. Wiley.

Jack Gido and James P. *Clements Successful Project Management* An International Thompson Publishing Company ISBM 0-538-88152-6

Frederick L. Harrison, Dennis Lock, *Advanced Project Management: A Structured Approach,* Gower Publishing, Ltd., ISBN 0566078228, 2003

Scott Berkun, *The Art of Project Management*, O'Reilly, ISBN 0596007868, 2005.

Harrold Kerzner. *Project management. A systems Approach to Planning, Building, Scheduling and Planning.* 10th Edition. John Wiley & Sons.

Project Management Institute. 2004. *A Guide to the Project Management Body of Knowledge.*

David I. Cleland, Ronald Gareis. *Global Project Management Handbook. Planiing, Organizing and Controlling International Projects.* 2006. McGraw Hill.

6.2.3 CIV7232 Structural Dynamics (3 CU)

Course Description

This course introduces free and forced vibrations of structural forms, with introduction to earthquake engineering. The course also covers analysis and design of structures subjected to dynamic loads by analytic numerical methods as well as use of computer programs in their solution.

Objectives

- To enable the student solve structural systems subjected to dynamic loads, with emphasis to earthquake loading.
- To tutor the student in the use of computer programs to solve structural systems subjected to dynamic loadings

Course Content
Equations of motion; free and forced vibrations of single degree of freedom systems; multi-degree of freedom systems; free vibrations, forced vibrations by harmonic, generalized, impulsive and random loadings; numerical solution of dynamic problems; introduction to earthquake engineering; introduction to probabilistic vibrations; linear and nonlinear problems.
Analysis and design of structures subjected to dynamic loads by analytic numerical methods; computer applications

Learning Outcomes
On completing the course the student should be able to:
- § solve structural systems subjected to dynamic loads, with emphasis to earthquake loading
- § use of computer programs to solve structural systems subjected to dynamic loadings

Mode of teaching/delivery
The course shall be conducted through lectures.

Mode of Assessment
Assessment will be done through continuous interim assessments (assignments and tests) and a final examination. Interim assessment will carry a total of 40% and final examination will carry 60% of the final grade mark.

Proposed Staff
Eng. Moses Matovu

Reading/Reference Materials
The instructor is to compile the reading list from several textbooks, journals, etc readily available in this area.

6.2.4 CIV7233 Stability of Structures (3 CU)

Course Description
This course deals with stability problems in structural forms and systems. Special consideration for stability during design of structural elements are highlighted. The course also covers the use of computer applications in the determination of the capacity and response of structures considering their structural stability.

Objectives
- solve structural systems considering effects of their structural stability
- use of computer programs analyze structural stability of common structural forms.

Course Content
Introduction to common areas of stability problems in structures, conservative and non-conservative loads, elastic and inelastic buckling of columns; stability of members under combined

bending and axial loads; buckling of frames; torsional buckling of open sections; lateral stability of beams and buckling of thin plates and shells; design consideration for stability; computer applications.

Learning Outcomes
On completing the course the student should be able to:

- § solve structural systems considering effects of their structural stability
- § use of computer programs to analyze structural stability of common structural forms

Mode of teaching/delivery
The course shall be conducted through lectures.

Mode of Assessment
Assessment will be done through continuous interim assessments (assignments and tests) and a final examination. Interim assessment will carry a total of 40% and final examination will carry 60% of the final grade mark.

Proposed Staff
Dr. Yasin Naku Ziraba
Prof. Jackson Mwakali

Reading/Reference Materials
The instructor is to compile the reading list from several textbooks, journals, etc readily available in this area.

6.2.5 CIV7236 Durability and Maintenance of Structures (3 CU)

Course Description
This course deals with the analysis of situations and problems requiring management decisions, planning and controlling construction projects as well as inspection and appraisal techniques. Also discussed are causes of deterioration and remedial measures.

Objectives
To enable the student make informed decisions regarding planning, controlling construction projects, inspection and appraisal techniques, as well as causes of deterioration and remedial measures.

Course Content
Analysis of situations and problems requiring management decisions, study of the concepts used in planning and controlling construction projects, time-cost analysis, bar charts and time-scaled diagrams. Inspection and appraisal techniques. Condition of structures and investigative assessment. Damages due to natural causes.
Extent and causes of deterioration and remedial measures. Fatigue and long-term effects, settlements, durability, time-dependence, reliability methods and code provisions. Prevention of corrosion and control of cracking. Protection methods and preventive measures. Strengthening of structures. Renovation by computer modeling. Repair systems and cost effectiveness. Repair materials. Specification of preventive measures. Maintenance. Demolition.

Learning Outcomes

On completing the course the student should be able to:

- § understand issues of management and take informed decisions regarding construction, inspection and appraisal techniques of structures.
- § assess the cause of deterioration and suggest remedial measures

Mode of teaching/delivery
The course shall be conducted through lectures.

Mode of Assessment
Assessment will be done through continuous interim assessments (assignments and tests) and a final examination. Interim assessment will carry a total of 40% and final examination will carry 60% of the final grade mark.

Proposed Staff
Eng. Paul Mujugumbya
Prof. Jackson Mwakali

Reading/Reference Materials
The instructor is to compile the reading list from several textbooks, journals, etc readily available in this area.

6.2.6 CIV7255 Finite Element Method (3 CU)

Course Description
This course deals the fundamental method of Finite Element as a numerical technique of solving partial differential equations, extended to applications in material and analysis of structural systems.

Objectives
To enable the student use the finite element technique to solve problems of material and and analysis of structural systems and components.

Course Content
Introduction to the fundamentals of Finite Element Method; variational and weighted residual methods. Application of the method to elastic problems of trusses, beams, plane frames, plane stress, plane strain, plate bending, axi-symmetric and three-dimensional solids; higher order and isoparametric elements; field and time-dependent problems of fluid and heat flow. Extension of the techniques to elastic-plastic, dynamics and solid mechanics problems; software development

Learning Outcomes
On completing the course the student should be able to:

- § formulate stiffness matrices of common element types with capability to develop such formulations for new elements
- § understand constitutive modelling of common engineering materials
- § solve structural systems using Computer Softwares

Mode of teaching/delivery
The course shall be conducted through lectures.

Mode of Assessment

Assessment will be done through continuous interim assessments (assignments and tests) and a final examination. Interim assessment will carry a total of 40% and final examination will carry 60% of the final grade mark.

Proposed Staff
Dr. Yasin Naku Ziraba

Reading/Reference Materials
The instructor is to compile the reading list from several textbooks, journals, etc readily available in this area.

6.2.7 CIV7256 Elasticity and Plasticity (3 CU)

Course Description
This course deals with basic fundamentals of continuum mechanics as applied to elasticity and plasticity of material behavior. Application of finite elements in elasticity and plasticity is also considered.

Objectives
To enable the student appreciate the application of theories of continuum mechanics to structural response of construction materials.

Course Content
Basic equations of continuum mechanics; plane elasticity; Airy's stress function; polynomial and generalized Fourier series solution to biharmonic equation; plane elasticity in polar coordinates; general foundation of plasticity theories including yield criteria, plastic flow rule, and generalized elasto-plastic shear strain relations; application of finite elements in elasticity and plasticity.

Learning Outcomes
On completing the course the student should be able to use the formulations based on principals of continuum mechanics to model the elastic and plastic behaviour of structural engineering materials.

Mode of teaching/delivery
The course shall be conducted through lectures.

Mode of Assessment
Assessment will be done through continuous interim assessments (assignments and tests) and a final examination. Interim assessment will carry a total of 40% and final examination will carry 60% of the final grade mark.

Proposed Staff
Dr. Yasin Naku Ziraba
Prof. Jackson Mwakali

Reading/Reference Materials
The instructor is to compile the reading list from several textbooks, journals, etc readily available in this area.

6.2.8 CIV7257 Advanced Computational Mechanics (3 CU)

Course Description
This course deals with application of computer/numerical procedures to advanced topics in mechanics, such as buckling of structures, large deformation and rotation, higher order theories, nonlinear elastic, plastic, and cracking of materials. Specific sub-routines shall be developed to obtain a computer solution to such problems.

Objectives
To enable the student develop competence in formulating problems of advanced topics in mechanics, their solution using numerical techniques and developing subroutines used to obtain a computer solution.

Course Content
Application of computer/numerical procedures to advanced topics in mechanics; these include buckling of structures, large deformation and rotation, higher order theories, nonlinear elastic, plastic, and cracking materials; software development.

Learning Outcomes
On completing the course the student should be able to:

- § develop competence in formulating problems of advanced topics in mechanics, their solution using numerical techniques
- § write subroutines and use them to obtain a computer solution to a given problem

Mode of teaching/delivery
The course shall be conducted through lectures.

Mode of Assessment
Assessment will be done through continuous interim assessments (assignments and tests) and a final examination. Interim assessment will carry a total of 40% and final examination will carry 60% of the final grade mark.

Proposed Staff
Dr. Yasin Naku Ziraba
Prof. Jackson Mwakali

Reading/Reference Materials
The instructor is to compile the reading list from several textbooks, journals, etc readily available in this area.

6.2.9 CIV7258 Analysis of Bridge Systems (3 CU)

Course Description
This course deals with the analysis and design of more complex structural bridge systems as well as use of computer applications in their solution.

Objectives
To enable the student analyse and design more complex structural bridge systems.

Course Content

Bridge loadings and bridge systems; deck structures and idealization; orthotropic plate theory and its application; use of finite difference and finite strip methods; composite bridges; pseudo slab, girder-slab and multi-beam type prestressed concrete bridges. design considerations for substructures; analysis of horizontally curved bridge decks; software applications in bridge analysis.

Learning Outcomes
On completing the course the student should be able to:

- § analyse and design more complex structural bridge systems
- § use of computer programs to analyse and design bridges

Mode of teaching/delivery
The course shall be conducted through lectures.

Mode of Assessment
Assessment will be done through continuous interim assessments (assignments and tests) and a final examination. Interim assessment will carry a total of 40% and final examination will carry 60% of the final grade mark.

Proposed Staff
Eng. Paul Mujugumbya
Eng. Moses Matovu

Reading/Reference Materials
The instructor is to compile the reading list from several textbooks, journals, etc readily available in this area.

6.2.10 CIV7259 Theory of Plates and Shells (3 CU)

Course Description
This course deals with the theory and design of thin shell structures, using the membrane and bending theories for of shells of revolution and translation, and their application to analysis of domes, hyperbolic, paraboloid, elliptic and cylindrical shells. The course also introduces the finite element method for plate bending.

Objectives

- To enable the student analyse and design thin shell structures including domes, hyperbolic, paraboloid, elliptic and cylindrical shells
- To enable the student formulate Finite Element Equations for solution of the structural response of plate bending problems

Course Content
Theory and design of thin shell structures. Membrane theory of shells of revolution and translation: Bending or general theory. Energy methods and thermal stresses in plates. Application of theories to analysis and design of domes; folded plates. Hyperbolic, paraboloid and elliptic shells, cylindrical concrete shell roofs and cylindrical tanks. Introduction to finite element method for plate bending.

Learning Outcomes
On completing the course the student should be able to:

- § analyse and design thin shell structures including domes, hyperbolic, paraboloid, elliptic and cylindrical shells
- § formulate Finite Element Equations for solution of the structural response of plate bending problems and obtain solutions to shell structures

Mode of teaching/delivery
The course shall be conducted through lectures.

Mode of Assessment
Assessment will be done through continuous interim assessments (assignments and tests) and a final examination. Interim assessment will carry a total of 40% and final examination will carry 60% of the final grade mark.

Proposed Staff
Dr. Yasin Naku Ziraba
Prof. Jackson Mwakali
Eng. Moses Matovu

Reading/Reference Materials
The instructor is to compile the reading list from several textbooks, journals, etc readily available in this area.

6.2.11 CIV7260 Decentralised Water Supply and Sanitation (3 CU)

Course Description
The course provides theoretical background and practical expertise in the field of low-cost decentralised water supply and sanitation alternatives specifically suitable for the small towns, peri-urban areas and urban slums, small island communities, tourist resorts etc. The course begins with a general introduction to water supply and sanitation situations in rural areas, small towns and rural growth centres as well as peri-urban and urban slums. It then presents the water supply systems including all their components, from source selection, abstraction, through treatment and supply/delivery to consumers. Also covered include the safe water chain as well as the system and risk assessment approach, giving rise to the concept of water safety plans. The course describes the various sanitation systems and their components, namely, conventional wastewater treatment, faecal sludge management, Ecological sanitation concepts, reuse of wastewater, excreta and grey water, Low-cost sewerage and drainage. Finally, the course presents management aspects of DWSS that include participatory planning and evaluation of DWSS systems, Multi-criteria decision support systems (MCDSS) in planning, financing and cost recovery, institutional arrangements and operation and maintenance aspects.

Objectives
The main objective of the course is to equip graduate students with theoretical background and practical expertise in the field of low-cost decentralised water supply and sanitation alternatives specifically suitable for the small towns, peri-urban areas and urban slums, small island communities, tourist resorts etc.
The specific objectives are to enable students to:

- be familiar with different technologies/methods for small-scale water abstraction, water treatment and sustainable sanitation technologies including nutrient reuse in agriculture.
- be able to prepare a basic engineering or concept design for the above mentioned technologies under the given conditions.
- be able to facilitate planning, financing, implementation and operation and maintenance of decentralised water supply and sanitation infrastructures based on stakeholder participation and community management.

Course Content

1. *Introduction* ***(6CH)***

1.1 Course introduction and major definitions

1.2 General introduction to water supply and sanitation situations in rural areas, rural growth centres and small towns, as well as peri-urban and urban slums.

2. *Water Supply Systems* ***(18CH)***

2.1 Water sources, supply systems, source selection, spring catchments and sand dams, wells and pumps, rainwater harvesting, water supply service levels.

2.2 Small-scale water treatment methods including household filters, solar water disinfection (SODIS)

2.3 Safe water chain, water safety plans (system and risk assessment).

3. *Sanitation Systems* ***(20CH)***

3.1 Basics of conventional wastewater treatment,

3.2 Ecological sanitation (introduction to ecosan, relevant treatment technologies, ecosan and agriculture, greywater treatment and reuse)

3.3 Faecal sludge management including energy recovery (biochar) and industrial applications

3.4 Low-cost sewerage and drainage.

4. *Management aspects of DWSS* ***(16CH)***

4.1 Participatory planning and evaluation of DWSS systems

4.2 Multi-criteria decision support systems (MCDSS) in planning

4.3 Financing and cost recovery

4.4 Institutional arrangements

4.5 Operation and maintenance aspects.

Learning Outcomes

On completing the course the students should be able to:

§ describe different technologies/methods for small-scale water abstraction, water treatment and sustainable sanitation technologies including nutrient reuse in agriculture.

§ to prepare a basic engineering or concept design for the above mentioned technologies under the given conditions.

§ to facilitate planning, financing, implementation and operation and maintenance of decentralised water supply and sanitation infrastructures based on stakeholder participation and community management.

Mode of teaching/delivery

The course shall be conducted through lectures, tutorials and field excursions. Course delivery will be by use of state-of-the-art methods using power point presentations and student centred/learner-centred methods pedagogy.

Mode of Assessment

Assessment will be done through continuous interim assessments (assignments, quizzes and tests) and a final examination. Interim assessment will carry a total of 40% and final examination will carry 60% of the final grade mark.

Proposed Staff

Dr. Charles Niwagaba
Dr. Robinah Kulabako
Dr. Herbert Kalibbala

Reading/Reference Materials

Feroze, A.M., Rahman, M. 2000. *Water Supply and Sanitation, Rural and Low Income Urban Communities*, 1st Edition, ITN-Bangladesh.

Francys R. P *A guide to the developmental of onsite sanitation* WHO, Geneva, Switzerland, 1992

Harvey, P.A. 2007. *Excreta disposal in emergencies. A field Manual*. An inter-Agency Publication. Published by WEDC, Loughborough University, UK.

Smet, J. and van Wijk, C. (editors) (2002). *Small Community Water Suppliers, Technology, People and Partnership*, Technical Paper Series 40, IRC International Water and Sanitation Centre, Delft, The Netherlands.

Kalbermatten, J.M., DeAnne, S.J., Mara, D.D., Gunnerson, C.G. 1980. Appropriate *Technology for Water and sanitation, A planner's Guide*.

Lüthi, C., Panesar, A., Schütze, T., Norström, A., McConville, J., Parkinson, J., Saywell, D., Ingle, R. 2011. *Sustainable Sanitation in Cities – A Framework for Action*. Sustainable Sanitation Alliaance (SuSanA) & International Forum on Urbanisation (IFoU), Papiroz Publishing House, The Netherlands. ISBN 978-90-814088-4-4.

Tilley, E., Lüthi, C., Morel, A., Zurbrügg, C., Schertenleib, R. 2008. *Compendium of sanitation systems and technologies*. EAWAG/Sandec (Swiss Federal Institute of Aquatic Science and Technology/Water and Sanitation in Developing Countries (EAWAG/Sandec) and Water Supply and Sanitation Collaborative Council (WSSS). ISBN 978-3-906484-44-0. 63.

WHO. 2006. *Guidelines for the safe use of wastewater, excreta and greywater*. *Volume 4. Excreta and greywater use in agriculture*. ISBN 92 4 154685 9.

Winblad, U. & Simpson-Herbert, M. (eds.), Calvert, P., Morgan, P., Rosemarin, A., Sawyer, R., Xiao, J. & Ridderstolpe, P. 2004. *Ecological Sanitation*. Revised and Enlarged Edition. Stockholm Environment Institute. ISBN 91 88714 98 5.

6.2.12 CIV7261 Solid waste Management and Recycling (3 CU)

Course Description

The course covers technological and non-technological aspects of solid waste management. Technological aspects include municipal solid waste collection, transfer, recycling, composting, anaerobic digestion, energy recovery, incineration, hazardous waste management and waste disposal on land. Non-technological aspects include policy development, legislation, institutional arrangements, financing, stakeholder involvement, and privatization of solid waste management services and operations.

Objectives

The main objective of this course is to provide students with up-to-date knowledge regarding technological, organisational and legislative developments and practices of handling solid wastes worldwide.

The specific objectives are to enable students to:

- to describe integrated solutions to the challenges posed by solid wastes in urban environment;
- to design a solid waste management system that is capable of functioning not only in situations where sufficient resources are available but also under the more challenging conditions usually prevailing in (large) cities in low-income countries.

Course Content

1. *Introduction* ***(10CH)***

1.1 Quantity and composition of municipal solid wastes
1.2 Introduction to solid waste management hierarchy
1.3 Solid waste practices world-wide
1.4 Link between poor solid waste management and environmental sanitation

2. *Technical aspects* ***(20CH)***

2.1 Municipal Solid Waste collection, transfer and transportation
2.2 Logistics of waste collection and transportation, reverse logistics, GIS application in route optimisation
2.3 Solid waste treatment processes of composting, anaerobic digestion
2.4 Incineration and energy recovery
2.5 Hazardous waste management
2.6 Municipal solid waste recycling

3. *Non-technological aspects* *(15CH)*

3.1 Policy development, legislation and institutional arrangements

3.2 Stakeholder involvement, financing, and privatization of solid waste management services and operations,

3.3 Solid waste ordinances and byelaws

4. *Development of a solid waste management master plan* *(15CH)*

4.1 How to prepare a solid waste management master plan

4.2 Good management practices in solid waste management

4.3 Case studies in relation to solid waste management master plans

4.4 Project on development of solid waste master plan

Learning Outcomes

On completing the course, students should be able:

- to define and implement integrated solutions to the challenges posed by solid wastes in urban environment;
- to design a solid waste management system that is capable of functioning not only in situations where sufficient resources are available but also under the more challenging conditions usually prevailing in (large) cities in low-income countries.

Mode of teaching/delivery

The course shall be conducted through lectures, tutorials and study tours/field visits. Course delivery will be by use of state-of-the-art methods using power point presentations and student centred/learner-centred methods pedagogy.

Mode of Assessment

Assessment will be done through continuous interim assessments (assignments, quizzes/tests, field study reports) and a final examination. Interim assessment will carry a total of 40% and final examination will carry 60% of the final grade mark.

Proposed Staff

Dr. Charles B. Niwagaba

Dr. Robinah N. Kulabako

Mr. Joel R. Kinobe

Reading/Reference Materials

Ali, M. (Ed.) 2004. *Sustainable Composting. Case studies and guidelines for developing countries*. The Water Engineering and Development Center (WEDC), Loughborough University, Leicestershire, UK. ISBN 1 84380 071 3.

Cointreau, S.J. 1982. *Environmental management of urban solid wastes in developing countries: a project guide*. Urban Development Department, The World Bank.

Epstein, E. (1997). *The Science of Composting*, CRC Press LLC, Boca Raton, London, New York, Washington D.C.

Flintoff, F. 1984. *Management of solid wastes in developing countries*. WHO Regional Publications, South-East Asia series no. 1. Taj services Ltd., Noida, UP. ISBN 92 9022 101 1.

Hansen, J.A. (Ed.) 1996. *Management of Urban Biodegradable Wastes. Collection, Occupational Health, Biological Treatment, Product Quality Criteria and End User Demands*. James & James

(Science Publishers) Ltd, London. ISBN 1-873936-58-3.

Haug, R.T. 1993. *The Practical Handbook of Compost Engineering*. Lewis Publishers. Lewis Publishers. Boca Raton, London, New York, Washington D.C.

Kim, P. 1998. *Community-Based Waste Management for Environmental Management and Income Generation in Low-Income Areas: A Case Study of Nairobi, Kenya*. Published by City Farmer, Canada's Office of Urban Agriculture.

Lardinois, I. van Klundert, A. 1993. *Organic waste: Options for small-scale resource recovery. Urban solid waste series 1*. Amsterdam, The Netherlands.

Maqsood, S.A.H. Md., Enayetuallah, I. 1997. *Waste as Resource*, The Bangladesh Observer. Raton, London, New York, Washington, D.C. ISBN 1-56676-478-5.

Robinson, W. D. (ed.). 1986. *The Solid waste Handbook, A practical guide*. John Wiley & Sons Inc. ISBN 0-471-87711-5.

Rouse, J.R., Ali, S.M. 2002. *Vehicles for People or People for Vehicles? Issues in Waste Collection*. WEDC, Loughborough University, UK. ISBN 1-84380-012-8.

Tchobanoglous, G., Kreith, F. 2002. *Handbook of Solid Waste Management*. Second Edition. McGraw-Hill Handbooks. ISBN 0-07-135623-1.

Tchobanoglous, G., Theisen, H., Eliassen, R. 1977. *Solid wastes. Engineering principles and Management Issues*. McGraw-Hill. ISBN 0-07-063235-9.

6.2.13 CIV7263 Policy, Laws and Institutions in Environmental Management (3 CU)

Course Description

The course provides theoretical background in the policies, laws and institutional framework relevant to environmental legislation, protection and management in Uganda. The course provides an overview of policies, laws and institutions for environmental management; Governance Issues, Rights to a decent environment; Institutions and the law: Local, national and international law and institutions (Transboundary watersheds: hydropolitics, human security, conflicts), The institutional context: roles and responsibilities; Monitoring and enforcement, Productive sanitation and wastewater re-use; Accessible and equitable distribution of Water and Sanitation Systems; Legal concerns of global environmental change: UN and other Conventions.

Objectives

The main objective of the course is to equip the students with theoretical background on policies, laws and institutional framework relevant to environmental legislation, protection and management in Uganda.

The specific objectives are to enable students to:

- be familiar with local, national and international policies, laws and institutional framework for environmental management in Uganda and beyond.
- be aware of the environmental rights as well as issues of equity as captured in the national, UN conventions and other relevant conventions,
- articulate negotiation issues of transboundary nature in regard to hydropolitics, environmental protection and climate change.

Course Content

1. *Introduction* ***(5CH)***

1.1 Overview of policies, laws and institutions in environmental management
1.2 Governance issues, rights to a decent environment, institutions and the law
1.3 Access and equitable distribution of water and sanitation systems.

2. *Transboundary watersheds* ***(15CH)***

2.1 Local, national and international policies and institutions.
2.2 Hydropolitics, human security, conflicts
2.3 The institutional concept in national and international environmental management – roles and responsibilities.
2.4 Monitoring and enforcement

3. *Productive sanitation and wastewater reuse/reclamation* ***(15CH)***

3.1 Religious and socio-cultural issues
3.2 Protection of consumers and disclosure issues
3.3 Ethical and gender issues
3.4 Risk assessment and mitigation

4. *Legal concerns of global Environmental Change* ***(10CH)***

4.1 Right to clean environment
4.2 UN and other conventions
4.3 Reducing emissions
4.4 The carbon foot print

Learning Outcomes

On completing the course the students should be able to:

- to interrelate institutions, policies and regulations related to environmental management at local, national, regional and international level.
- describe environmental rights as well as issues of equity as captured in the national, UN conventions and other relevant conventions,
- articulate negotiation issues of transboundary nature in regard to hydropolitics, environmental protection and climate change.

Mode of teaching/delivery

The course shall be conducted through lectures, by Makerere University senior staff. Where possible, practitioners in the field will be invited to give lectures and share experiences with the course participants. Course delivery will be by use of state-of-the-art methods using power point presentations and student centred/learner-centred methods pedagogy.

Mode of Assessment

Assessment will be done through continuous interim assessments (assignments, quizzes and tests) and a final examination. Interim assessment will carry a total of 40% and final examination will carry 60% of the final grade mark.

Proposed Staff

Dr. Charles Niwagaba
Dr. Robinah Kulabako

Herbert Mpagi Kalibbala

Reading/Reference Materials

1. Abernethy, C. 1997. *Water Management in the 21st Century*: Development and Cooperation 2/1997 Frankfurt.
2. Agreements relating to River Nile.
3. Anderson, F.R., Mandelkor, D.R. 1984. *Environmental Protection: Law and Policy* Little Brown and Co.
4. Biswas, A. K. 1993. *Management of International waters: Problems and Perceptive* WR development 9(a) p 1267-188.
5. Ministry of Health (MoH), 1999. *National Health Policy*, Ministry of Health, Government of Uganda.
6. Ministry of Water, Lands and Environment (MWLE), 1999. *Water Policy*, Ministry of Water, Land and Environment, Uganda.
7. NEMA 1995. The National Environment Statute, Government of Uganda.
8. NEMA 1997. *Environmental Impact Assessment Guidelines*. NEMA, Uganda.
9. NEMA 1999. *The National Environment (Waste Management) Regulations*, Government of Uganda.
10. NEMA 2003. *The National Environment (Noise Standards and Control) Regulations*, Government of Uganda.
11. NEMA 2007. *State of the Environment Report for Uganda*; and all other updated versions of the State of Environment Report for Uganda.
12. NEP, 1997
13. Nile Basin Initiative 2000.
14. The Constitution of the Republic of Uganda, as at 15th February 2006, Government of Uganda.
15. The Constitution of the Republic of Uganda.
16. The Public Health Act 1964 (Government of Uganda).
17. The Ugandan Water Act
18. The Water Statute 1995 (Government of Uganda).
19. The Workers' Compensation Act (Act 8), 2000.
20. UN conventions and Charters relating to environment and climate change.

6.2.14 CIV7264 Water Quality Management (4 CU)

Course Description

This course is intended to make students appreciate the importance of water quality management, physical, chemical and biological characteristics of water and their significance in different water systems; Water quality monitoring and monitoring strategy; sources of contaminants; water quality standards and indicators; Institutional and legal framework regarding water quality in Uganda and Introduction to modeling of water quality in natural systems.

Objectives

- Introduce the concepts of water quality management and monitoring
- To understand the physical, chemical and biological characteristics of water and their significance
- To learn ways to improve water quality through treatment and management of chemically and biologically polluted waters
- To appreciate the importance of water quality monitoring and development of monitoring strategy
- Recognize the role of water quality guidelines and legislation in water quality management
- Provide a practical understanding of the significance of water quality management to society and the role of water practitioners in the management process

Course Content

1. ***Introduction*** ***(3CH)***

2. ***General Water Quality Characteristics*** ***(6CH)***

2.1 Physical water quality parameters
2.2 Chemical water quality parameters
2.3 Biological water quality parameters

3. ***Significance of the Characteristics of Water*** ***(8CH)***

3.1 Water quality in rivers
3.2 Water quality in lakes and reservoirs
3.3 Water quality in groundwater aquifers
3.4 Water quality in aquaculture

4. ***Movement of contaminants in the environment*** ***(8CH)***

4.1 Point Sources of Pollution
4.2 Non-point Sources of Pollution
4.3 Types of pollutants
- Ø Municipal wastewater discharge
- Ø Agriculture related water impurities
- Ø Industrial related water impurities

5. ***Standards and criteria for drinking water/irrigation water/water in industry*** ***(4CH)***

6. ***Institutional and legal framework regarding Water Quality Pollution control in Uganda*** ***(4CH)***

7. ***Introduction to water quality monitoring techniques*** ***(8CH)***

Design of water quality monitoring networks

Water quality sampling program
- Ø Selection of sampling stations
- Ø Sampling frequency
- Ø Representative sampling
- Ø Types of samples and preservation of samples
- Ø Field quality assurance requirements

- Ø Transportation and storage of samples
- Ø Safety during field work

8. *Modeling of water quality in natural systems* *(4CH)*

9. *Laboratory work* *(15CH)*

Learning Outcomes

At the end of the course, the students should be able to:

- § Appreciation of the importance of water quality management and monitoring
- § Understanding of the physical, chemical and biological characteristics of water and their significance
- § Recognition of the role of water quality guidelines and legislation in water quality management in Uganda
- § Getting a practical understanding of the significance of water quality management to society and the role of water practitioners in the management process
- § Getting appropriate skills for development of water quality monitoring strategies for different water systems.

Mode of Delivery

The mode of delivery is through lectures, tutorials, laboratory work and case study project.

Mode of Assessment

Assessment will be done through continuous interim assessments (assignments, tests and project report) and a final examination. Interim assessment will carry a total of 50% and final examination will carry 50% of the final grade mark.

Proposed Staff

Dr. Robinah Kulabako

Dr. Charles NIwagaba

Mr. Herbert M. Kalibbala

Mr. Martin Tumutungire

References

Isobel W. Heathcote, (1998*). Integrated watershed management: Principle and practice*. John Wiley & Sons, Inc.

Steven C. Chapra (2008). *Surface water quality modelling*. Waveland Pr Inc. ISBN-13:978-1577666059.

Bartram J. and Balance R. (1996). *Water Quality Monitoring: A practical guide to the design and implementation of freshwater quality studies and monitoring programmes*. E & FN Spon on behalf of UNESCO, WHO & UNEP. ISBN 0-419-22320-7.

APHA/AWWA/WEF (1999). *Standard methods for the examination of water and wastewater*, 20th Edition. American Public Health Association, American Water Works Association and Water Environment Federation (APHA/AWWA/WEF) Publication. Washington D.C, USA. ISBN-13:978-0875532356.

Howard A. G. (2002). Water quality surveillance: A practical guide. WEDC, Loughborough. ISBN 1 84380 0039.

ARGOSS (2001). *Guidelines for Assessing the Risk to Groundwater from On-site Sanitation*. British Geological Survey Commissioned Report, CR/01/142. National Environmental Research Council, London.

Environmental Legislation of Uganda. National Environmental Management Authority (NEMA), Uganda.

Summerfelt, Robert C. (n.d). *Water quality considerations for aquaculture*. Aquaculture Network Information Centre (http://aquanics.org)

6.2.15 CIV7238 Earth Structures (3 CU)

Course Description

The course provides participants with fundamentals and working tools needed for the design and analyses of earth structures and earth retention systems. The course covers the selection, design and performance of earth retention structures used for support of fills and excavations. Theory regarding earth pressures and soil reinforcement interaction are covered. Some case histories illustrating the selection, design and performance of various earth retaining structures

Objectives

- To introduce the participants to the various earth retention systems, their applicability, limitations and design
- To introduce the participants to advanced analysis of the lateral earth pressures involving friction as opposed to Rankine's smooth walls

Course Content

1. *Introduction* ***(5CH)***

1.1 Types of earth retaining systems
- 1.1.1 Classification
- 1.1.2 Overview of fill wall systems
- 1.1.3 Overview of of cut wall systems
- 1.1.4 Selection of wall systems

2. *Earth pressure theory* ***(5CH)***

2.1 Mohr's circle
2.2 At rest , active and passive earth pressures
2.3 Rankine thory. Influence of movement on earth pressures
2.4 Earth pressure from surcharge loads
2.5 Coloumb theory
2.6 The idea of roughness ratio

3. *Design of externally stabilized fill walls* ***(5CH)***

3.1 External stability
3.2 Design of CIP gravity and semi-gravity walls
3.3 Design of modular gravity walls

4. *Reinforcing elements* ***(5CH)***

4.1 Functions and types of geosynthetics
4.2 Polymers

4.3 Fundamentals of soil-reinforcement interaction
4.4 Mechanical properties of metallic and polymeric reinforcements

5. *Design of internally stabilized fill walls* ***(5CH)***
5.1 Internal stability
5.2 Design of mechanically stabilized earth (MSE) walls
5.3 Design of reinforced steep slopes

6. *Design internally stabilized cut walls* ***(5CH)***
6.1 Design of soil nail walls
6.2 Other systems

7. *Design of externally stabilized cut walls* ***(5CH)***
7.1 Design of sheet pile walls
7.2 Design of anchored walls

8. *Advances in earth retention walls* ***(5CH)***
8.1 Construction aspects
8.2 Deformability analysis of earth retention systems
8.3 Performance monitoring of retaining structures
8.4 Bridge abutment
8.5 LRFD

9. *Advances in soil-reinforcement systems* ***(5CH)***

Learning Outcomes
On completing the course the student should be able to:

- Identify the types, advantages and disadvantages of the different earth retaining systems (e.g gravity structures, soil nailing et.c)
- Quantify the lateral earth pressures associated with different earth retaining systems
- Select the most technically appropriate and cost-effective type of retaining wall for a given project based on a clear understanding of the many available systems
- Use design tools for the analysis of both internal and external stability including use of hand calculations and state-of -the art computer programs

Mode of teaching/delivery
The course shall be conducted through lectures, tutorials and self-study.

Reading material / References

Koerner R.B (2005): *Designing with Geosynthetics*. 5th Ed.. Prentice Hall

Das, B.M (1999): *Principles of Foundation Engineering*, 4th Ed. Brooks/Cole Publishing

Tanyu B.F, Sabatini P.J, Berg R.R (2005). *Earth Retaining Structures*. Publication no. FHWA NHI-05-046, National High Institute, US Dept. of Transportation

6.2.16 CIV7265 Ground Improvement (3 CU)

Course Description
This course will introduce students to the concepts underpinning a range of ground improvements

and soil remediation techniques and an appreciation of how these techniques are applied in practice. It will cover important design and construction aspects associated with ground improvement techniques including: mechanical methods, hydraulic methods, physical/chemical methods, inclusions and soil remediation techniques.

Objectives

- To gain an understanding of the concepts behind a range of ground improvement and soil remediation techniques.
- Describe advantages, disadvantages, and limitations for each ground improvement method discussed.
- Ability to identify appropriate techniques for a range of ground and site conditions.
- Locate criteria to determine the applicability of each ground improvement method for a specific project and soil condition under consideration.

Course Content

1. ***Introduction to Ground improvement*** ***(1CH)***

2. ***Mechanical methods*** ***(10CH)***
- 2.1 Compaction
- 2.2 Explosives
- 2.3 Vibro-floation
- 2.4 Vibro-replacement

3. ***Hydraulic methods*** ***(10CH)***
- 3.1 Groundwater lowering
- 3.2 Preloading
- 3.3 electroosmosis

4. ***Physical/chemical methods*** ***(8CH)***
- 4.1 Admixtures
- 4.2 Grouting
- 4.3 Freezing

5. ***Inclusions*** ***(8CH)***
- 5.1 Reinforcements
- 5.2 Geosynthetics
- 5.3 Soil nailing

6. ***Soil remediation techniques.*** ***(8CH)***

Learning Outcomes

On completing the course the student should be able to:

§ Understand the different soil improvement methods; the degree to which soil properties may be improved; and the benefits involved.

§ Design ground improvement projects as well as be able to advise regarding value engineering to save cost and obtain maximum benefits for the specific project.

Mode of teaching/delivery

The course shall be conducted through lectures, tutorials, and self-study of case-histories.

Reading material / References

U.S. Army Corps of Engineers, (1999) *Guidelines on ground improvement for structures and facilities*, Department of The Army, ETL 1110-1-185.

Charles, J. A. (1993): *Building on Fill: Geotechnical Aspects*, BRE Report CI/SFB C (D) (J12).

Clarke, B.G., Jones, C.J.F.P., Moffat, A.I.B. (eds.) (1993): *Engineered Fills*, p.553, Thomas Telford.

Holtz, R.D. (ed.) (1988): *Geosynthetics for Soil Improvement*, ASCE Special Publication No.18

Jones, C.J.F.P. (1996): *Earth Reinforcement and Soil Structures*, Thomas Telford

Manfred Housman, (1990): *Engineering Principles of Ground Modification*, McGraw Hill, p.632.

Harris et al., (1996): *Land Restoration and Reclamation: Principles and Practice*.

Sarsby, R., (2000): *Environmental Geotechnics*, Thomas Telford Publishing, London.

Craig R.F., *Soil Mechanics*, 7th Edition.

6.2.17 CIV7266 Laboratory and Field Soil Investigations (3 CU)

Course Description

The course aims at equipping the participants with comprehensive knowledge of the mechanical properties of soils. The course gives a theoretical background as practical aspects of the mechanical properties of soils covered though lectures, field and laboratory exercises. Planning of site investigations and preparation of Geotechnical reports are covered in this course. Obtaining suitable design parameters for Geotechnical work is also discussed but no design work is undertaken.

Objectives

- To introduce the participants to the purpose of soil investigations, the different field techniques and their limitations
- To understand the plan and design of site investigations; what should be done, who should be involved and the extent of the investigations
- To introduce the participants to the routine laboratory tests, strength tests, deformation and compaction tests and how suitable design parameters are derived from them
- To train participants in writing Geotechnical investigation reports.

Course Content

1. *Introduction* ***(5CH)***

1.1 Purpose of soil investigations.
1.2 Codes of Practice: the Euro code, BS, etc.
1.3 Planning site investigations

2 . *Field Investigations* ***(7CH)***

2.1 Field sounding techniques and their limitations
2.2 Soil sampling techniques
2.3 Obtaining in situ soil parameters of strength, deformation, permeability
2.4 Introduction to geophysical techniques and their limitations

3. *Laboratory Investigations* *(7CH)*

3.1 Index and classification soil tests
3.2 Shear strength tests using the Direct shear box, simple shear and triaxial
3.3 Deformation behaviour of soil using the incremental and CRS oedometer
3.4 Response of soil to compaction
3.5 Determination of permeability
3.5 Aspects of soil disturbance and their influence on test results

4. *Obtaining design parameters from investigation data* *(6CH)*

5. *Preparation of Geotechnical Reports* *(5CH)*

6. *Practical sessions in the lab* *(15CH)*

Learning Outcomes

On completing the course the student should be able to:

- Plan and design site investigations for moderately large civil engineering projects
- Select appropriate field and laboratory investigative procedures that suit the desired purpose
- Understand the mechanical behaviour of soils and henceforth select suitable design parameters for use in LE and FE codes.

Mode of teaching/delivery

The course shall be conducted through lectures, tutorials, field and laboratory exercises. The course will involve a Site Investigation Project with regular colloquia with presentation and discussion of test results.

Reading material / References

There are many books that cover the material included in this course. These generally have titles similar to course name.

6.2.18 CIV7267 Slope Stability (3 CU)

Course Description

This course focuses on stability of natural slopes and stability considerations related to man-made cuts and fills. Focus will be on the conditions up to and until the slide is initiated. Post-failure description and mass transport will not be handled. The course participants will be introduced to the different slide mechanisms and the conditions of their occurrence. Theory and principles governing stability of slopes will be handled ranging from simple hand calculations to finite element simulations. The course will also include some international case records of landslides.

Objectives

- Gain knowledge of the effective engineering approaches for identifying and analyzing unstable slopes.
- Understand the different slide mechanisms
- Understand how landslides and other slope displacements due to natural causes and human activities are identified and mitigated against.

- Understand the different slope stabilization techniques, their applicability and limitations.
- Introduce the participants to LE and FE-codes commonly used in analyzing slope stability.

Course Content

1. ***Introduction*** ***(1CH)***
2. ***Limit analysis techniques of analyzing slopes*** ***(10CH)***
3. ***Use of stability charts to assess slope stability*** ***(10CH)***
4. ***Deterministic and probabilistic approaches in slope stability*** ***(7CH)***
5. ***Rock stability assessments*** ***(5CH)***
6. ***FE analysis of slopes*** ***(6CH)***
7. ***Slope monitoring techniques*** ***(3CH)***
8. ***Slope stabilization techniques*** ***(3CH)***

Learning Outcomes

On completing the course the student should be able to:

§ Identify the different slide mechanisms; their geotechnical-triggering factors, characteristics
§ Understand the various analysis techniques and the principles and methods of slope stabilization.

Mode of teaching/delivery

The course shall be conducted through lectures, tutorials, self-study of case-histories and computer trainings on how to use FE and LE-codes.

Mode of Assessment

Assessment will be done through continuous interim assessments (assignments and tests) and a final examination. Interim assessment will carry a total of 40% and final examination will carry 60% of the final grade mark.

Proposed Staff

Dr. Denis Kalumba

Reading material / References

Holtz. R. and Kovacs. W. (1981): *An introduction to Geotechnical Engineering*, Prentice-Hall,Inc.

Abrahamson W. Lee, Boyce. M. Glenn, Thomas. S. Lee, Sharma Sunil, and: *Slope Stability and Stabilization methods,* 2nd Ed. John Wiley and sons.

Bromhead, E. N. (1986): *The Stability of Slopes*, Surrey Univ Press.

Duncan. J. Michael and Wright. G. Stephen : *Introduction to Soil strength and slope stability,* Wiley and Sons.

Craig R.F., *Soil Mechanics*, 7th Edition

6.2.19 CIV7268 GIS System for Water Resources (3 CU)

Course Description

Most Water Resources' project involve the use of Geographical Information Systems (GIS), Such projects require extensive knowledge and the use and GIS for spatial manipulation of natural

resources while ensuring effective Water resources Manipulation. Although the modelling of water resources bases on GIS is rather complex and yet a recent approach compared to conceptual methods, it enables detailed representation of several hydrological processes such as flows over the surface and underground.

Objectives

The course is intended to provide the student with:

- Use of GIS for Hydrological and Hydraulics representation
- Use of GIS for surface and subsurface modelling
- Use of GIS for spatial representation of surface and subsurface water resources

Course Content

1. ***Definition of Geographical information system*** ***(2CH)***

1.1 GIS Definition
1.2 Benefits
1.3 Applications
1.4 GIS Applications in Water Resources Engineering

2. ***Representation of Space*** ***(4CH)***

2.1 Modelling and Abstraction
2.2 Spatial Paradigms - Objects/Fields
2.3 Vector Data Model
2.4 Raster Data Model
2.5 TIN/Digital Elevation (surface) Modelling

3. ***GIS Spatial Operation*** ***(4CH)***

3.1 Vector (editing features; Intersecting Features; Union Features; Dissolving Features, etc)
3.2 Raster Analysis (Simple arithmetic operations e.g. addition, differencing, DVI)
3.3 Focal, local and zonal functions

4. ***GIS Database Development*** ***(4CH)***

4.1 Conceptual Modelling
4.2 Logical modelling
4.3 Physical modelling
4.4 Modelling spatial features- Topology
4.5 Comparison of modelling techniques for spatial and descriptive databases

5. ***Data Capturing and Management for Water Resources*** ***(8CH)***

5.1 Techniques for data capture
- Using primary Methods (Land Surveying; Global Positioning ; systems)
- Remote Sensing/Image integration for Water Resources Modules

5.2 Using Secondary Method
- Digitising techniques in water resources

5.3 GIS Integration Issues
- Spatial reference Systems
- Datums, Projections, Coordinate systems

- The UTM and associated data integration issues in Uganda

6. ***Spatial Data Analysis*** ***(4CH)***

7. ***GIS-Based Water Resources Modeling Programmes*** ***(4CH)***
Case Studies (Land Information Systems, Soil information systems, Digital Elevation Models and Integrated Modelling

8. ***GIS based Water Resources Modelling Project*** ***(15CH)***
Individual projects in Water Resources for Surface and Groundwater using GIS bases programmes such as SWAT.

Learning Outcomes
On completing the course the student should be able to:

- Have a basic understanding of GIS and GIS data model
- Develop using GIS, a water resources model and how to manage this in GIS
- Undertake spatial analysis of water resources data in GIS
- Appreciate the use of GIS in water resources management

Mode of teaching/delivery
The course shall be conducted through lectures, tutorials and practicals.

Mode of Assessment
Assessment will be done through continuous interim assessments (assignments, practicals and tests) and a final examination. Interim assessment will carry a total of 40% and final examination will carry 60% of the final grade mark.

Proposed Staff
Dr. Max Kigobe
Dr. Bennie Mangeni

Reading/Reference Materials
David R. Maidment (Ed.) (2002). *Arc Hydro: GIS for Water Resources* – DVD ROM. ESRI Press. ISBN-10:9781589480346, ISBN-13:978-1589480346.

John G. Lyon (Ed.) (2002). *GIS for Water Resource and Watershed Management*. CRC Press. ISBN-10:0415286077, ISBN-13:978-0415286077.

David J. Maguire, Michael F. Goodchild and Michael Batty (Eds) (2005). *GIS Spatial Analysis and Modeling*. ESRI Press, ISBN-10:9781589481305, ISBN-13:978-1589481305.

Christopher Lloyd (2010). *An introduction for GIS users*. Oxford University Press, USA. ISBN-10:9780199554324, ISBN-13:978-0199554324.

David R. Maidment and Dean Djokic (Eds) (2000). *Hydrologic and Hydraulic Modeling support with Geographic Information Systems*. ESRI Press. ISBN-10:1879102803, ISBN-13:978-1879102804

6.2.20 CIV7249 Hydraulic Engineering (3 CU)

Course Description
This course exposes students to the application of mathematical and scientific principles in hydraulics to the planning, modelling, design, development and operational evaluation of systems

that are applied in collecting, storing, moving, conserving and controlling water. The course covers aspects of drainage and flood protection, hydraulic structures, sediment transport, and hydraulic machines.

Course Objectives

The course is intended to provide the student with:

- an advanced understanding of hydraulics as applied to the environment and to Civil Engineering works.
- an overview of the main components of hydraulic structures
- ability to dimension all parts of hydraulic systems in channels and rivers
- an understanding of design, operation and application of hydraulic structures
- ability to evaluate planning, design, operation and performance of implicating hydraulic systems in an overall context of a fluvial system.
- an understanding of the use of hydraulic machines in Civil Engineering projects.
- ability to utilize their hands-on experience in the step-by-step modeling procedure (geometry, bathymetry, boundary conditions, forcing) needed to carry out a practical study with MIKE11, SOBEK 1D or HEC-RAS package
- ability to apply physical models in planning of hydraulic systems

Course Content

1. *Introduction* ***(3CH)***

1.1 Historical development
1.2 Application of hydraulics
1.3 Hydrometry

2. *Sediment transport* ***(5CH)***

4.1 Erosion and sedimentation
4.2 Sediment properties
4.2 Mechanics of sediment transport in Channels and rivers
4.2 Sediment-Load measurement
4.3 Mechanism of sedimentation in reservoirs
4.4 Sediment control measures

3. *Advanced hydraulic structures* ***(6CH)***

4.1 Flow regulation structures
4.2 Flow measuring structure
4.3 Discharge structures
4.4 Hydraulic and Structural Dimensioning
4.5 Design Criteria for Flood Protection Structures
4.6 Design Criteria for Vertical and Stepped Weirs (Application of Blight's and Lane's methods)
4.7 Structural and Geotechnical Aspects related to Dam Engineering.

4. *Pumping Stations* ***(6CH)***

5.1 Types of Pumps and their Operation
5.2 Pump Characteristics

5.3 Pump and the Pipe System
5.4 Pump Selection
5.5 Methods of Flow Control
5.6 Water Hammer

5. *Mathematical modelling* *(4CH)*

6.1 Introduction
6.2 Hydraulic problems described by ordinary differential equations
6.3 Case Study: 1-D Mathematical Model
6.4 Case Study: 2-D Mathematical Model

6. *Physical modelling* *(6CH)*

6.1 Introduction (Application areas and Limitations)
6.2 Elements of the Dimensional Analysis
6.3 Theory Hydraulic Model Investigations
6.4 Dimensional Analysis in Derivation of Mechanical Similarity Laws
6.5 Application of Navier-Stokes Equations to Derive Mechanical Similarity Hydrodynamics
6.6 Analogy of Electrical and Hydraulic Phenomena
6.7 Models of Hydraulic Structures
6.8 Case Study and Design Procedure
6.8 Consideration about Scale Effects and Scale Selection
6.10 River Models with Fixed Bed

7. *Laboratory practice and Field work* *(15CH)*

6.1 Design of hydraulic experiments
6.2 Physical models
6.3 Flow measurement in the Field

Learning Outcomes

On completing the course the student should be able to:

- § Apply hydraulic principles to evaluate planning, design, operation and performance of implicating hydraulic systems in an overall context of a fluvial system.
- § Carry out assessment and design of complex hydraulic systems
- § Carry out independent experimental assessment of hydraulic problems through application of both
- § Mathematical and Physical models

Mode of teaching/delivery

The course shall be conducted through lectures, tutorials and practicals.

Mode of Assessment

Assessment will be done through continuous interim assessments (assignments, practicals and tests) and a final examination. Interim assessment will carry a total of 40% and final examination will carry 60% of the final grade mark.

Proposed Staff

Dr. Max Kigobe
Mr. Apollo Buregyeya
Mr. Michael Kizza

Reading/Reference Materials

Jorde, K., Sommer, F. 2006: *Design of Hydraulic Structures* – Hydro Power Schemes.

Fluid Mechanics, Douglas J F, Gasiorek J M, and Swaffield J A, Longman.

Hydraulics in Civil and Environmental Engineering, Chadwick A, and Morfett J., E & FN Spon - Chapman & Hall.

McGraw-Hill Science, *Engineering/Math*; 2 edition (March 23, 2009)

Hubert Chanson, 2004: Hydraulics of Open Channel Flow: An Introduction - Basic Principles, Sediment Motion, Hydraulic Modeling, Design of Hydraulic Structures (Second Edition), Butterworth Heinemann, UK

Terry Sturm, 2009; *Open Channel Hydraulics*; McGraw-Hill Science/Engineering/Math; 2 edition

Romuald Szymkiewicz, 2010; *Numerical Modeling in Open Channel Hydraulics* (Water Science and Technology Library) Springer; 1st Edition.

6.2.21 CIV7252 Urban Hydrology (3 CU)

Course Description

This course is intended to make students appreciate the methods used in the analysis and design of urban hydraulic structures. It will deal with river flood management and flood management in urban drainage. It will also introduce integrated urban water management and case studies.

Objectives

- To learn about urban infrastructure and water systems
- To learn about analytical methods in urban hydrology and their applications.
- To learn about design standards and methods for urban hydraulic structures
- To learn about flood management in rivers and urban areas
- To learn about integrated urban water management and case studies.

Course Content

1. *Urban Water* ***(6CH)***
- 1.1 Urban Development
- 1.2 Urban Infrastructure Planning
- 1.3 Urban Water Systems

2. *Analytical Methods* ***(9CH)***
- 2.1 Data requirements
- 2.2 Rainfall Runoff Models
- 2.3 Statistical Methods - Frequency Analysis

3. *Hydraulic Structures* ***(9CH)***
- 3.1 Design Standards and Methods

3.2 Storm water
3.3 Wastewater
3.4 Combined Sewers

4. *River Flood Management* ***(6CH)***
4.1 Structural Measures
4.2 Non Structural Measures
4.3 Evaluating Flood damage

5. *Flood Management in Urban Drainage* ***(6CH)***
5.1 Management of drainage systems
5.2 Sustainable Management
5.3 Control Measures

7. *Integrated Urban Water Management* ***(6CH)***
7.1 Management Phases
7.2 Urban and Watershed Management
7.3 Storm water Management
7.4 Operations and Maintenance

8. *Case Studies* ***(3CH)***

Learning Outcomes
On completing the course the student should be able to:
- § appreciate urban infrastructure and water systems
- § understand the methods used in the analysis of hydrologic variables.
- § understand design standards and methods for urban hydraulic structures
- § understand flood management in rivers and urban areas.
- § learn about integrated urban water management and case studies.

Mode of teaching/delivery
The mode of delivery is through lectures and tutorials.

Mode of Assessment
Assessment will be done through continuous interim assessments (assignments and tests) and a final examination. Interim assessment will carry a total of 40% and final examination will carry 60% of the final grade mark.

Proposed Staff
Dr. Max Kigobe
Mr. Michael Kizza
Dr. Albert Rugumayo

Reading/Reference Materials

Shaw, E.M., *Hydrology in Practice*, Chapman and Hall, 1994, London, UK

Mansell, M.G. *Rural and Urban Hydrology*, Thomas Telford, 2003, London, UK

Subramanya, K., *Engineering Hydrology*, 2nd Edition 2001,Tata McGraw Hill, New Dehli, India.

Haan, C.T. *Statistical Methods in Hydrology*, Iowa University Press 2002, Iowa, USA

Wilson, E.M., *Engineering Hydrology*, 4th Edition, Macmillan, 1996, London, UK.

Duggal, K.N., Soni, J.P., *Elements of Water Resources Engineering*, New Age Publishers, 2007, Dehli, India.

Singh, V. P. *Hydrologic Systems*, Prentice-Hall Englewood Cliffs, 1989 New Jersey, USA

Watkins L.H, Fiddes D., *Highway and Urban Hydrology in the Tropics*. Pentech Press, 1984, London, UK.

Rugumayo, A.I., *Lecture Notes, An Introduction to Hydrology and Water Resources Engineering*, Lecture Notes, Kampala, 2010

Tucci, C.E.M., *Urban Flood Management*, the World Meteorological Organization and Cap-Net International Network for Capacity Building in Integrated Water Resources Management, 2007,Geneva, Switzerland.

Butler,D., Davies, J.W., *Urban Drainage*, E& FN Spon,2000, London, UK

Novotny, V., Ed. *Non-point Pollution and Urban Storm Water Management*, Vol 9 Technomic Publishing Company, 1995, Pennsylvania, USA

Kolsky P., *Storm Drainage, An Engineering Guide to the Low Cost Evaluation of System Performance in the Tropics*, Intermediate Technology Publications, 1999, London, UK.

Tucci, C.E.M., *Urban Drainage in Humid Tropics*, International Hydrological Programme, UNESCO, 2001, Paris.

6.2.22 CIV7269 Hydrological Data Processing and Modelling (3 CU)

Course Description

The course provides fundamental knowledge and practical understanding for the common statistical techniques of data processing in hydrology and water engineering. This knowledge and understanding must allow the students to select and apply most appropriate techniques to summarize and organize data. It also allows them to have an insight in the limitations of data collection, and the corresponding consequences for water management and engineering.

Objectives

The course is intended to enable the student to:

- process hydrological data from field form into usable form
- classify different types of hydrological models, when and how to use them
- understand general equations and subroutines which are used to describe a hydrological model
- use some hydrological models for predictions of flows and water management.

Course Content

1. ***Types of hydrological data*** ***(2CH)***
2. ***Measurement of hydrological variables*** ***(4CH)***
3. ***Use of information technology for hydrological data processing*** ***(4CH)***

4. ***Evapotranspiration in hydrological modeling*** ***(4CH)***
5. ***Model calibration and validation methods*** ***(2CH)***
6. ***Stochastic models*** ***(2CH)***
7. ***Conceptual models (HBV, WASMOD)*** ***(4CH)***
8. ***Physically based models (SWAT)*** ***(2CH)***
9. ***Prediction in ungauged basins*** ***(2CH)***
10. ***Hydrological models in climate change studies*** ***(2CH)***
11. ***Model Applications*** ***(2CH)***
12. ***Laboratory practice (data processing, hydrological modelling)*** ***(15CH)***

Learning Outcomes

On completing the course the student should be able to:

- § Process raw hydrological data using state-of-the-art techniques
- § Understand the factors used in the selection of hydrological models and their limitations
- § Build simple hydrological models
- § Use advanced hydrological models for solving water resources problems

Mode of teaching/delivery

The course shall be conducted through lectures, practicals tutorials.

Mode of Assessment

Assessment will be done through continuous interim assessments (assignments, practicals and tests) and a final examination. Interim assessment will carry a total of 40% and final examination will carry 60% of the final grade mark.

Proposed Staff

Dr. Max Kigobe
Mr. Michael Kizza

Reading/Reference Materials

Hydrology in Practice, Elizabeth M. Shaw et al., 4th Edition

Distributed Hydrological Modelling, by Michael B Abbott, Jens Christian Refsgaard, Springer

Hydrological Modelling, by Frederic P Miller, Bertrams Print

6.2.23 CIV7270 Groundwater Hydrology (3 CU)

Course Description

The course provides fundamental knowledge and practical understanding for the occurrence of groundwater in an area, citing of wells and main tools in groundwater investigation. This knowledge and understanding allows students to select and apply most appropriate techniques in assessing the groundwater potential of an area and optimal siting of wells.

Objectives

The course is intended to provide the student with:

- Identification methods for areas of high groundwater potential
- Techniques for appropriately siting wells
- Well construction and development techniques
- Application of well hydraulic equations
- Techniques for determination well characteristics
- Groundwater investigation methods

Course Content

1. Basic concepts of hydrology/geohydrology
2. Origin of groundwater
3. Groundwater flow and measurement
4. Darcy's Law
5. Basic equations of groundwater flow
6. General Flow equations
7. Laplace equation
8. Confined and unconfined aquifers
9. Water well design
10. Well hydraulics
11. Pumping and Recovery test
12. Remote Sensing in groundwater investigation
13. Satellite data in groundwater investigation
14. Use of isotopes in groundwater investigation
15. Ground geophysics
16. Natural and artificial groundwater recharge
17. Groundwater modeling techniques

Learning Outcomes

On completing the course the student should be able to:

- § Apply various techniques to identify the groundwater resources potential of an area
- § Appropriately site wells in an area
- § Evaluate the various techniques in groundwater investigation

Mode of teaching/delivery

The course shall be conducted through lectures, tutorials and field exercises.

Mode of Assessment

Assessment will be done through continuous interim assessments (assignments, practicals and tests) and a final examination. Interim assessment will carry a total of 40% and final examination will carry 60% of the final grade mark.

Proposed Staff

Dr. Mangeni Bennie

Dr. Max Kigobe

Reading/Reference Materials

David A Chin (2006), *Water Resources Engineering*, Prentice Hall,NJ

Fetter CW (1994), *Applied Hydrology*, Macmillan Publishing Company

Dingman LS (1993), *Physical Hydrology*, Prentice Hall, NJ

Maidment D (1992), *Handbook of Hydrology*

Walton WC (1970), *Groundwater Resources Evaluation*

Todd D K (1959), *Groundwater Hydrology*, John Wiley &Sons NJ

6.2.24 CIV7243 Structural Design of Pavements (3 CU)

Course Description

This course covers aspects on design of new pavements through simple and easily applied methods for determining appropriate pavement structures for the expected design criteria. The process of design entails selection of possible structural configurations that should meet the design criteria. Suggested designs are checked against mechanistic analysis methods for suitability.

Objectives

The aims of this course are to:

- Evaluate response of the pavement to traffic loads,
- Determine wheel loading for purposes of design,
- Assess layer thicknesses for both flexible and concrete pavements.

Course Content

1. *Pavement design philosophy* ***(2CH)***

Pavement types

Wheel loads and pressures
Design factors
Distresses
The design process
Performance – serviceability concept

2. *Stresses and strains in flexible and rigid pavements* ***(6CH)***

Layered systems

Multi layered systems
Visco-elastic systems
Sources of stresses in rigid pavements

3. *Traffic consideration in design* ***(7CH)***

Equivalent single wheel load

Equivalent wheel load factor
Aircraft wander
Variable traffic

4. *Engineering characteristics and use of pavement Materials* ***(7CH)***

Soil classifications – AASHTO and FAA

Characterization parameters
Layer materials – Surfacing, Base, Subbase and subgrade
Material variability

5. *Design of flexible highway pavements* ***(8CH)***

Mechanistic methods
Empirical methods
Design methods – AASHTO and MoWT

6. *Design of rigid highway pavements* ***(6CH)***

Design factors
Reinforcement
Design methods

7. *Design of flexible airport pavements* ***(5CH)***

FAA method
Other methods

8. *Design of rigid airport pavements* ***(4CH)***

Modulus of rupture
Design charts

Learning Outcomes

At the end of this course, a student should be able to:

- Estimate cumulative traffic loading expected during the design life.
- Define strength of the subgrade over which the road will be built.
- Define the nominal operating climate (wet or dry).
- Determine any practical aspects which will influence the design selection.
- Select possible pavement structures.

Mode of teaching/delivery

The teaching of students will be conducted through lectures, tutorials, short classroom exercises, group discussions among the students and projects aimed at solving real life problems. Solving real life problems in each theme or a number of topics will enhance the students' understanding of the problem based learning techniques.

Mode of Assessment

Assessment will be done through coursework which will include assignments, class room and take home tests, project work and a written examination. Course work will carry a total of 40% and written examination carries 60%. Coursework marks will be divided into; Assignments 5%, Tests 10% and Practical Work 25%.

Proposed Staff

Dr. Umaru Bagampadde

Reading/Reference Materials

A guide to the structural design of bitumen-surfaced roads in tropical and sub-tropical countries. 1993. Crowthorne, UK: Transport Research Laboratory.

Code of Practice for Pavement Rehabilitation. 1998. Maputo, Mozambique: Southern Africa Transport and Communications Commission (SATCC).

Structural design of flexible pavements for inter-urban and rural roads. 1996. Pretoria, SA: Department of Transport. (Technical Recommendations for Highways Draft TRH4).

Subsurface drainage for road. 1994. Pretoria, SA: Department of Transport. (Technical Recommendations for Highways Draft TRH15).

Surfacing seals for rural and urban roads. 1998. Pretoria, SA: Department of Transport. (Technical Recommendations for Highways Draft TRH3).

Standard specifications for road and bridge works. 1998. Maputo, Mozambique: Southern Africa Transport and Communications Commission (SATCC).

American association of state highway and transportation Officials (1993). *AASHTO Guide for Design of Pavement Structures*.

Cement and concrete association of Australia (1997). *Interim Concrete roads manual.*

E. J. Yoder and M. W. Witczak (1975). *Principles of pavement design, second*, 2nd *Edition.*

Huang Y. H., *Pavement Analysis and Design*, Prentice Hall, Upper Saddle River, New Jersey, 07458, (1993).

6.2.25 CIV7244 Performance and Rehabilitation of Pavements (3 CU)

Course Description

This course covers pavement performance aspects, evaluation and rehabilitation activities conducted on roads usually on annual basis, sometimes several times a year and even weekly, if conditions so require. These activities may be divided into cyclic and reactive work types. Typical periodic maintenance works include overlay works on paved roads and regravelling on unpaved roads.

Objectives

The aims of this course are to:

- Assess the condition of the pavement during its service life,
- Evaluate performance in terms of distresses of the pavement,
- Assess remedial economical methods of rehabilitation.

Course Content

1. *Performance indicators for pavement systems* ***(5CH)***
- Serviceability concepts
- Roughness measurements
- Distresses

2. *Quality control in construction* ***(5CH)***
- Field management of construction
- Quality control and assurance
- Testing and QC Charts

3. *Plant in road construction* ***(5CH)***
- Plant types
- HMA facilities
- Transportation and lay-down operations
- Compaction

4. *Maintenance programmes* ***(4CH)***

Labour based
Machine based),

5. *Rehabilitation of highway and airport pavement systems* ***(5CH)***
Maintenance – Preventive/corrective
Rehabilitation
Recycling
Overlays

6. *Nondestructive techniques* ***(4CH)***
Structural evaluation
Back calculation

7. *Computer applications* ***(2CH)***
Pavement evaluation
Maintenance

8. *Practicals* ***(15CH)***

Learning Outcomes
At the end of this course, a student should be able to:

- § Response of the pavement to traffic wheel loads
- § Assess the need and level of rehabilitation intervention
- § Recommend the most viable method for rehabilitation

Mode of teaching/delivery
The teaching of students will be conducted through lectures, tutorials, short classroom exercises, case studies, group discussions among the students and projects aimed at solving real life problems.

Mode of Assessment
Assessment will be done through coursework which will include assignments, class room and take home tests, project work and presentations and a written examination. Course work will carry a total of 40% and written examination carries 60%.

Proposed Staff
Dr. Umaru Bagampadde

Reading/Reference Materials
De Beer, M. 1991. *Use of the dynamic cone penetrometer in the design of road structures*. Proceedings of the 10th Regional Conference for Africa on Soil Mechanics and Foundation Engineering. Maseru, Lesotho.

Draft guidelines on the use of bitumen emulsion treated materials. 1998. Cape Town, SA. Southern African Bitumen Association (Sabita).

Semmelink, C.J. 1991. *The effect of material properties on the compactibiliy of some untreated road building materials*. PhD dissertation, University of Pretoria, South Africa.

6.2.26 CIV7245 Pavement Materials (3 CU)

Course Description

This course covers the characteristics of various materials that may be used in a pavement structure, performance prediction based on material characteristics, material recyclability, quality control and selection for maintenance and rehabilitation.

Objectives

The aims of this course are to:

- Understand the methods used to test for material characteristics
- Determine methods used to model material behaviour in pavements
- The quality control procedures in material production and application

Course Content

1. ***The nature, engineering characteristics, testing, and selection of materials for highway and airport pavements*** ***(6CH)***

Bitumen – properties, tests and grading
Aggregates - properties, tests and grading
Sands – properties and tests
Additives and modifiers (Mineral and liquid)
Others

2. ***Bituminous Materials*** ***(6CH)***

2.1 Composition,
2.2 Physical Behavior,
2.3 Mix Design – Marshall, Hveem and Superpave
2.4 Production
2.5 Performance

3. ***Concrete and mix design*** ***(6CH)***

3.1 Production of concrete
3.2 Conditions under production
3.3 Mix design

4. ***Durability of concrete and asphalt mixes*** ***(4CH)***

4.1 Performance
4.2 Concrete failures

5. ***Recycling of pavement materials*** ***(4CH)***

5.1 Introduction
5.2 Candidates for recycling
5.3 Design considerations
5.4 Production of recycled mixtures

6. ***Recent developments in pavement materials*** ***(4CH)***

6.1 Latest equipment
6.2 Latest tests

7. ***Practicals*** ***(15CH)***

Learning Outcomes

At the end of this course, a student should be able to:

§ Test of characteristics of the materials
§ Determine material suitability for a particular setting based on its characteristics,
§ Assess methods for improvement of material performance.

Mode of teaching/delivery
The teaching of students will be conducted through lectures, tutorials, short classroom exercises, practicals, and projects aimed at solving real life problems.

Mode of Assessment
Assessment will be done through coursework which will include assignments, class room and take home tests, practicals and a written examination. Course work will carry a total of 40% and written examination carries 60%. Coursework marks will be divided into; Assignments 5%, Tests 10% and Practical Work 25%.

Proposed Staff
Dr. Umaru Bagampadde

Reading/Reference Materials
Roberts, R. L., Kandhal, P. S., Brown, E. R., *Hot Mix Asphalt Materials, Mixture Design, and Construction,* NAPA Publication, Library Of Congress, 1991.

Whiteoak D., 1991, *The Shell Bitumen Handbook*, Shell Bitumen UK.

6.2.27 CIV7246 Transportation Planning and Modelling (3 CU)

Course Description
This course covers the fundamental principles of planning for and modeling transportation in a complex fabric of society involving diverse activity systems and economies.

Objectives
The aims of this course are to:

- Assess the methods using in planning for transportation systems in society.
- The course will introduce methods and techniques for modeling and analysis of components and systems for transportation.

Course Content

1. ***Comprehensive transportation planning*** ***(6CH)***
- The process of planning
- Short, medium and long term planning

2. ***Transportation surveys*** ***(20CH)***
- Traffic surveys
- Socio-economic surveys
- O-D studies
- Modal split
- Network assignment
- Planning and choice models

3. ***Traffic forecasting*** ***(7CH)***
- Forecasting models
- Forecasting parameters

4. ***Transportation land use modeling*** ***(6CH)***
- Inter zonal planning considerations

Legislation

5. *Travel evaluation and demand estimation* *(6CH)*

Demand and supply

Urban transport considerations

Learning Outcomes

At the end of this course, a student should be able to:

- § Identify and explain the transportation planning process for both short and long ranges.
- § Determine outcomes from the generic 4 step transportation process – Generation, distribution, modal split and network assignment.

Mode of teaching/delivery

The teaching of students will be conducted through lectures, classroom exercises, term projects aimed at solving real life problems and group discussions among the students. The lecture material will be availed to the students in advance to enable them have prior reading. Solving real life problems in each theme or a number of topics will enhance the students' understanding of the problem based learning techniques.

Mode of Assessment

Assessment will be done through coursework which will include assignments, class room and take home tests, project work and presentations and a written examination. Course work will carry a total of 40% and written examination carries 60%. Coursework marks will be divided into; Assignments 5%, Tests 10% and Practical Work 25%.

Proposed Staff

Dr. Umaru Bagampadde

Reading/Reference Materials

Michael Meyer, Eric J. Miller. Urban Transportation Planning, McGraw-Hill, 2nd edition, 2000. ISBN 0072423323

Ascott, Elizabeth. 2006. Benefit Cost Analysis of Wonderworld Drive Overpass in San Marcos, Texas. Applied Research Project. Texas State University. http://ecommons.txstate.edu/arp/104/

Arentze T and Timmermans H (2000). "A Learning-Based Transportation Oriented Simulation System". *Transport Res B-Meth* 38: 613–633.

Shiftan Y. (2000). "The advantage of activity-based modeling for air-quality purposes: theory vs practice and future needs". *Innovation* 13 (1): 95–110.

Beckx C, Arentze T, Int Panis L, Janssens D, Vankerkom J, Wets G (2009). "An integrated activity-based modeling framework to assess vehicle emissions: approach and application". *Environment and Planning B: Planning and Design* 36 (6): 1086–1102.

Paul H. Wright and Norman J. Ashford, Transportation Engineering, planning and design, fourth edition. Pgs 189-192

6.2.28 CIV7271 Mix design/Bituminous and Concrete (3 CU)

Course Description

This course sets guidance and recommendations relating to procedures used to determine mixture component material quality as well as the proportions in which they are supposed to be mixed. The

result of the mix design process is a job-mix formula (JMF), a starting point for the contractor in producing material mixtures for a project. The responsible engineer and contractor generally verify the JMF based on plant-produced mixture from a trial batch. If the JMF fails the verification check using the trial batch, the JMF is adjusted or the mix may be redesigned. Additional plant-produced trial batches are run until the JMF is verified. During the project execution, the JMF may be modified without developing a new mix design to achieve specified requirements as long as adjustments do not exceed tolerances established within the applicable mix specification.

Objectives

The objective of this course is to familiarize students with the asphalt concrete, and Portland cement concrete and some additives used in the highway infrastructure. The course covers the classical methods plus newly developed methods used for asphalt concrete and Portland cement concrete and high performance concrete.

Course Content

1. *History of Mix Design* ***(6CH)***

Historical crude methods
Advent of modern methods

2. *Mix types* ***(7CH)***

Large stone mixes
Dense graded mixes

3. *Asphalt Mix design methods* ***(7CH)***

Hubbard – Field methods
Hveem method
Marshall Method
Superpave method

4. *Portland Concrete Design methods* ***(6CH)***

5. *Characterization methods* ***(9CH)***

Asphalt concrete
Portland Cement Concrete

6. *Practical Sessions* ***(20CH)***

Learning Outcomes

At the end of this course, a student should be able to:

- Judiciously select the right materials
- Determine the right material proportions for proper performance

Mode of teaching/delivery

The teaching of students will be conducted through lectures, tutorials, short classroom exercises, group discussions among the students and projects aimed at solving real life problems.

Mode of Assessment

Assessment will be done through coursework which will include assignments, class room and take home tests, project work and presentations and a written examination. Course work will carry a total of 40% and written examination carries 60%.

Proposed Staff

Dr. U. Bagampadde

Ms. M. Namutebi

Dr. A. G. Kerali

Reading/Reference Materials

Hot Mix Asphalt Materials, Mixture Design, and Construction, (second edition) by F.L. Roberts, P.S. Kandhal, E.R. Brown, D.Y. Lee, and T.W. Kennedy; NAPA Research and Education Foundation, 5100 Forbes Blvd., Lanham, Maryland 20706-4413. Phone: 301-731-4748, 2nd ed., 1996.

Background of SUPERPAVE Asphalt Binder Test Methods, R.B. McGennis, S. Shuler, H.U. Bahia, Asphalt Institute, Lexington Kentucky, 1994.

Background of SUPERPAVE Asphalt Mixture Design and Analysis, R.B. McGennis, R.M. Anderson, T.W. Kennedy, M. Solaimanian, Asphalt Institute, Kentucky, 1995.

Design and Control of Concrete Mixtures, S.H. Kosmatka and W.C. Panarese,13th ed., Portland Cement Association, Skokie, Illinois, 1988.

Teaching the Materials Science, Engineering, and Field Aspects of Concrete, Seventh Annual ACBM/PCA Undergraduate Faculty Enhancement Workshop, Purdue University, 2000.

6.2.29 CIV7272 Traffic Systems Analysis (3 CU)

Course Description

This course covers a field which draws on engineering, economics, operations research, political science, psychology, management, and other disciplines. The course considers intercepting and examining traffic flows in order to deduce information from patterns in communication.

Objectives

The aims of this course are to:

1. Develop an understanding of how quantitative models and tools can be used to analyze and evaluate transport and traffic systems, and in particular with respect to the implementation of different ITS systems.
2. Gain fundamental knowledge in modelling theory.
3. Overview the market of relevant modelling tools and software.
4. Acquire insight in how to use relevant modelling tools and software in practice.

Course Content

1. ***Application of systems approach to transportation*** ***(7 CH)***

The challenge of transportation

The transportation system

System options

Consequences of transportation - impacts

2. ***Determination of transportation demand and supply*** ***(8CH)***

Prediction of flows

Other elements of prediction

Human behaviour – Individual and Aggregate

Behavioural models

3. *The equilibrium process* ***(8CH)***

Service and demand functions
Flow patterns
System models

4. *Transportation system evaluation* ***(8CH)***

Disaggregate prediction of behavior
Variations in Level of Service
Aggregate prediction of behavior
Elasticity of demand

5. *Cost-effectiveness techniques* ***(8CH)***

Benefit Costs Analysis
The time dimension
Capital recovery factor
Equivalent annual cost method
Net present value method

6. *Use of optimization techniques in transportation* ***(6CH)***

Minimization/Maximization methods
Practical examples

Learning Outcomes

At the end of this course, a student should be able to:

- § Determine the demand for traffic.
- § Apply modelling in assessing flow.
- § Planning for traffic movements.

Mode of teaching/delivery

The teaching of students will be conducted through lectures, tutorials, short classroom exercises, case studies, group discussions among the students and projects aimed at solving real life problems. The lecture material will be availed to the students in advance to enable them have prior reading. Solving real life problems in each theme or a number of topics will enhance the students' understanding of the problem based learning techniques.

Mode of Assessment

Assessment will be done through coursework which will include assignments, class room and take home tests, project work and presentations and a written examination. Course work will carry a total of 40% and written examination carries 60%. Coursework marks will be divided into; Assignments 5%, Tests 10% and Practical Work 25%.

Proposed Staff

Dr. Umaru Bagampadde
Godfrey Mwesige

Reading/Reference Materials

M L Manheim. *Fundamentals of transportation systems analysis Vol.1*. MIT Press, 1978.

6.3 Semester III

6.3.1 CIV8101 Seminar Series (2 CU)

Course Description

The course helps students to strengthen their ability to do guided research, make a report on technical issues and present these issues in a scientific set up. While lecturers will give the students guidelines on the topics to research on, they will not formally teach them in class. However, what is expected out of the students will be explicitly given to them and examined.

Objectives

The aims of the course are:

- To develop the students' ability to search for and internalize scientific academic material;
- To develop the student's skills in technical writing; and
- To develop the student's presentation skills.

Learning Outcomes

At the end of this course unit, the students should be able to:

§ Read and internalize scientific academic material in his/her area of study;

§ Adequately and competently report academic findings in technical documents (reports, articles, etc);

§ Prepare good presentations for dissemination of scientific findings; and competently present scientific findings.

Mode of teaching/delivery

Students will be given broad areas of study together with research questions to address by the beginning of the second semester. Each student will be given a senior staff from whom they can get advice and guidance whenever necessary. The student will then be required to address one research problem and make a write up on it. The student will then be required to present his work to the staff and his/her peers. As part of the course, the student will also be obliged to attend all (weekly) research talks in the faculty (for the Year II: semester I & II for Plan A and Semester II for Plan B).

Course Content

The content is both in terms of skill and technical content.

- Technical content: This depends on the problem addressed. The student is expected to show understanding and comprehension of the subject matter.
- Skill content: a student is expected to show ability to comprehend scientific literature, correctly make a technical report and competently prepare and make an academic presentation.

Method of Assessment

Assessment will be made up of 4 parts:

- Attendance of research talks (Semester 2) 10%
- Report writes up 50%
- Presentation 20%
- Knowledge of subject matter 20%

Reading/Reference Materials

The textbooks and articles will depend on the problem being addressed.

6.3.2 CIV8102 Advanced Reinforced Concrete (3 CU)

Course Description

This course deals with the design of more complex structural elements of reinforced concrete, with emphasis on computer modeling for the analysis and design of reinforced concrete structures.

Objectives

To enable the student design more complex structural elements of reinforced concrete and model their behavior using computer applications.

Course Content

Moment-curvature for RC members, design and behaviour of continuous flexural members, two-way floor systems, design of slender columns, beam-column joints; deflection of RC members; design for shear and torsion; foundation design; computer modelling for analysis and design of RC structures.

Learning Outcomes

On completing the course the student should be able to design more complex structural elements of reinforced concrete and model their behavior using computer softwares.

Mode of teaching/delivery

The course shall be conducted through lectures, practicals and site visits.

Mode of Assessment

Assessment will be done through continuous interim assessments (assignments, practicals and tests) and a final examination. Interim assessment will carry a total of 40% and final examination will carry 60% of the final grade mark.

Proposed Staff

Eng. Paul Mujugumbya
Eng. Moses Matovu

Reading/Reference Materials

The instructor is to compile the reading list from several textbooks, journals, etc readily available in this area.

6.3.3 CIV8103 Behaviour and Design of Steel Structures (3 CU)

Course Description

This course deals with advanced concepts of elasto-plastic material behavior, fracture and fatigue applied to steel structures and their composite construction as well as design of rigid frames, second order analysis and rigid and semi-rigid connections.

Objectives

To enable student design complex steel elements employing the theories of elasto-plastic material behavior, fracture and fatigue.

Course Content

Elastic-plastic concepts of structural behaviour; plastic design of beams and frames; design of plate girders, compression members with large width-thickness ratio and stiffened plate; composite design and behaviour, behaviour of rigid and semi-rigid connections; design considerations for fracture and fatigue; design of rigid frames; behaviour of multi-storey frames and second-order analysis.

Learning Outcomes

On completing the course the student should be able to design complex steel elements and their composite construction employing theories of elasto-plastic material behavior, fracture and fatigue.

Mode of teaching/delivery

The course shall be conducted through lectures.

Mode of Assessment

Assessment will be done through continuous interim assessments (assignments and tests) and a final examination. Interim assessment will carry a total of 40% and final examination will carry 60% of the final grade mark.

Proposed Staff

Prof. Jackson Mwakali

Eng. Moses Matovu

Reading/Reference Materials

The instructor is to compile the reading list from several textbooks, journals, etc readily available in this area.

6.3.4 CIV8104 Fracture of Materials (3 CU)

Course Description

This course deals with basic principals of linear elastic fracture mechanics with extension to elasto-plastic fracture theories applied to crack propagation under cyclic loading. The course also introduces fracture mechanics design process and discusses applications of fracture mechanics to plain and reinforced concrete.

Objectives

To enable the student understand the role fracture of brittle materials plays in determining their load carrying capacity, and how to use theories of fracture mechanics to design structures made up of plane and reinforced concrete

Course Content

Stress intensity computations in linear elastic fracture mechanics (LEFM); finite element including singularity elements in LEFM, compliance calibration for critical energy release rate computations, mixed mode fracture criteria. Elasto-plastic fracture principles, crack propagation under cyclic loading; fracture mechanics design process; applications of fracture mechanics to plain and reinforced concrete.

Learning Outcomes
On completing the course the student should be able to:

- § determine capacity of brittle materials using theories of fracture mechanics
- § use theories of fracture mechanics to design structures made up of plane and reinforced concrete

Mode of teaching/delivery
The course shall be conducted through lectures.

Mode of Assessment
Assessment will be done through continuous interim assessments (assignments and tests) and a final examination. Interim assessment will carry a total of 40% and final examination will carry 60% of the final grade mark.

Proposed Staff
Dr. Yasin Naku Ziraba
Prof. Jackson Mwakali

Reading/Reference Materials
The instructor is to compile the reading list from several textbooks, journals, etc readily available in this area.

6.3.5 CIV8105 Prestressed Concrete (3 CU)

Course Description
This course deals with the analysis and design of prestressed concrete systems and their construction, including an introduction to segmental form of construction.

Objectives
To enable the student analyse and design prestressed concrete structural systems.

Course Content
Prestressing systems; materials; behaviour of prestressed concrete beams; criteria for analysis and design; losses; analysis of stresses; flexural design; shear; end blocks; deflection; composite members; continuous beams; partial prestressing, design applications; introduction to segmental construction.

Learning Outcomes
On completing the course the student should be able to analyse and design prestressed concrete structural systems.

Mode of teaching/delivery
The course shall be conducted through lectures, practicals and site visits.

Mode of Assessment
Assessment will be done through continuous interim assessments (assignments, practicals and tests) and a final examination. Interim assessment will carry a total of 40% and final examination will carry 60% of the final grade mark.

Proposed Staff

Eng. Paul Mujugumbya
Eng. Moses Matovu

Reading/Reference Materials
The instructor is to compile the reading list from several textbooks, journals, etc readily available in this area.

6.3.6 CIV8106 Advanced Structural Dynamics (3 CU)

Course Description
This course deals with more advanced topics in dynamic analysis of structural elements including beams, plates and shells. The course emphasizes numerical solutions, non-linear analysis of Multiple Degree of Freedom systems, probabilistic structural dynamics and earthquake engineering.

Objectives
- To enable the student perform more complex dynamic analysis of structural elements such as beams, plates and shells
- To enable the student use probabilistic structural dynamics to obtain solutions to structures subjected to earthquake.

Course Content
Dynamic analysis of distributed parameter systems including beams, plates and shells: effects of shear deformations and rotary inertia: discretization of continuous systems; numerical solutions of eigen-value problems; nonlinear analysis of MDOF systems; probabilistic structural dynamics: earthquake engineering.

Learning Outcomes
On completing the course the student should be able to:
- § perform more complex dynamic analysis of structural elements such as beams, plates and shells
- § use probabilistic structural dynamics to obtain solutions to structures subjected to earthquake

Mode of teaching/delivery
The course shall be conducted through lectures.

Mode of Assessment
Assessment will be done through continuous interim assessments (assignments and tests) and a final examination. Interim assessment will carry a total of 40% and final examination will carry 60% of the final grade mark.

Proposed Staff
Eng. Moses Matovu

Reading/Reference Materials
The instructor is to compile the reading list from several textbooks, journals, etc readily available in this area.

6.3.7 CIV8107 Continuum Mechanics (3 CU)

Course Description
This course deals with basic fundamentals of continuum mechanics with applications to elasticity, visco-elasticity, plasticity, and fluid mechanics with an introduction to continuum damage mechanics.

Objectives

- To equip the student with fundamental principals of continuum mechanics and how they could be used to derive constitutive relations and response of materials subjected to loads.
- To introduce the students to continuum damage mechanics

Course Content
Tensors, indicial notation, transformation of coordinates; analysis of stress, principal stresses; 3D Mohr's circle; analysis of deformation and strain; velocity fields and compatibility conditions; constitutive; equations; isotropy; mechanical properties of solids and fluids; field equations; applications to elasticity, visco-elasticity, plasticity, and fluid mechanics; introduction to continuum damage mechanics.

Learning Outcomes
On completing the course the student should be able to:

- § use the principals of continuum mechanics to derive constitutive relations and response of materials subjected to loads
- § assess capacity of structural elements using the theory of continuum damage mechanics.

Mode of teaching/delivery
The course shall be conducted through lectures.

Mode of Assessment
Assessment will be done through continuous interim assessments (assignments and tests) and a final examination. Interim assessment will carry a total of 40% and final examination will carry 60% of the final grade mark.

Proposed Staff
Dr. Yasin Naku Ziraba
Prof. Jackson Mwakali

Reading/Reference Materials
The instructor is to compile the reading list from several textbooks, journals, etc readily available in this area.

6.3.8 CIV8108 Constitutive Modelling of Materials (3 CU)

Course Description
This course deals with several constitutive models for materials including linear-elastic, non-linear elastic hyper-elastic, hypo-elastic, variable modulii incremental, elastic-perfectly plastic fracture etc. The course also introduces the finite element formulation for elasto-plastic problems.

Objectives

To expose the student to the several material constitutive models available to predict the structural response of elements subjected to load.

Course Content
Deviatoric stress and strain tensors; geometric representation of stress and concept of Pi-plane; strain energy and complementary energy density in elastic solids; non-linear elastic stress-strain relations; Cauchy and hyper-elastic models; incremental (hypo-elastic) model for isotropic materials; variable moduli incremental stress-strain models; multi-parameter failure criteria; elastic perfectly plastic fracture models; finite elements in elasto-plastic problems.

Learning Outcomes
On completing the course the student should be able to use any of the several material constitutive models available to predict the structural response of elements subjected to load.

Mode of teaching/delivery
The course shall be conducted through lectures.

Mode of Assessment
Assessment will be done through continuous interim assessments (assignments and tests) and a final examination. Interim assessment will carry a total of 40% and final examination will carry 60%

Proposed Staff
Dr. Yasin Naku Ziraba
Prof. Jackson Mwakali

Reading/Reference Materials
The instructor is to compile the reading list from several textbooks, journals, etc readily available in this area.

6.3.9 CIV8109 Boundary Element Method (3CU)

Course Description
This course deals with the Boundary Element Method as yet another useful technique of solving governing differential equations with applications to one and two dimensional problems of steady-state potential flow and elasto-static and time dependent problems. Computer algorithms are developed and applications in various engineering fields discussed.

Objectives
To equip the student with yet another useful technique of solving governing differential equations, and its application to several engineering fields.

Course Content
Weighted residual methods: weak formulations; inverse formulations, fundamental solutions; one-dimensional problems; two-dimensional problems of steady-state potential flow: two-dimensional problems of elasto-statics; time dependent problems; algorithm design and software development; application in various engineering fields.

Learning Outcomes
On completing the course the student should be able to use the formulations of the Boundary Element Method to solve practical problems in engineering.

Mode of teaching/delivery
The course shall be conducted through lectures.

Mode of Assessment
Assessment will be done through continuous interim assessments (assignments and tests) and a final examination. Interim assessment will carry a total of 40% and final examination will carry 60% of the final grade mark.

Proposed Staff
Dr. Yasin Naku Ziraba
Prof. Jackson Mwakali

Reading/Reference Materials
The instructor is to compile the reading list from several textbooks, journals, etc readily available in this area.

6.3.10 CIV8110 Mechanics of Composite Materials (3 CU)

Course Description
This course deals with the analysis and design of structural element composites constituted of orthotropic laminates such as laminated beams and plates. The course looks at their strength, deflection, and buckling, as well as the mechanics of their fracture. Also a finite element formulation is discussed.

Objectives
To enable the student analyse and design structural elements constituted of orthotropic laminates, basing on their strength, deflection, and buckling, as well as the mechanics of their fracture.

Course Content
Stress-strain for orthotropic lamina, effective moduli and strength of a continuous fiber-reinforced lamina, laminate analysis, delamination, matrix cracking and durability; analysis of lamina hygrothermal behaviour; analysis of laminated beams and plates; deflection and buckling of laminates; fracture mechanics of composite materials; finite element applications.

Learning Outcomes
On completing the course the student should be able to analyze and design structural elements constituted of orthotropic laminates, basing on their strength, deflection, and buckling, as well as the mechanics of their fracture.

Mode of teaching/delivery
The course shall be conducted through lectures.

Mode of Assessment
Assessment will be done through continuous interim assessments (assignments and tests) and a final examination. Interim assessment will carry a total of 40% and final examination will carry 60% of the final grade mark.

Proposed Staff
Dr. Yasin Naku Ziraba

Prof. Jackson Mwakali

Reading/Reference Materials
The instructor is to compile the reading list from several textbooks, journals, etc readily available in this area.

6.3.11 CIV8111 Environmental Impact Assessments & Monitoring

Course Description
The course introduces students to Environmental Impact Assessment (EIA). The course is designed to provide a critical overview of the theory and practice of EIA. The EIA process is introduced including the history and evolution of EIA. Policy, laws and EIA administration. Monitoring environmental ecosystems and carrying out environmental audits. The course includes field trips to selected projects.

Objectives

The objective of the course is to:

- The purpose of Environmental Impact Assessments
- Introduce the EIA process and governing regulations
- Exposure to various impact assessments
- Introduce students to Environmental auditing
- Strategic Environment Assessment and Application

Course Content

1. ***Introduction***: sustainable development concept, instruments for sustainable development and EIA.
2. Evolution of the EIA process, the main functions of EIA, importance and benefits of EIA, Implementation of EIA (Policy, Laws and Institutions).
3. ***EIA procedure***: initial screening or initial environmental examination (IEE), scoping and preparation of terms of reference, assessing project environment(baseline data collection or studies, impact prediction, impact interpretation), identification of mitigation/enhancement measures, identification of monitoring requirements, EIA report/EIS preparation, reviews of EIS, decision-making and approval, project implementation (of mitigation, enhancement and monitoring),
4. ***Public participation***: the EIA team formation, EIA methods, data sources and data collection, sector checklists. EIA stakeholder's roles and responsibilities.
5. Technical impact assessments on water, air, soil, noise, social and health. Project specific impacts (industrial, hydropower, irrigation, urban infrastructure, transportation, water supply, sanitation, waste management). Transboundary environmental assessment and international agreements,
6. Environmental Monitoring, life cycle assessment, Environmental Management systems (EMS).
7. Environmental Audits (EA); overview, environmental audit policies, guidelines for environmental audit, post audit activities.
8. Environmental regulations and environmental standards.
9. Strategic Environmental Assessment (SEA) process (definition and scope, tiering); SEA and decision making procedures, general approach,

10. SEA application to privatisation, structural and sectoral adjustment programs, trade agreements, laws and regulations. Environmental assessment and ethics

Learning outcomes

- By the end of the course, students should be able to:
- Explain the origins of EIA
- Outline the different stages of EIA;
- Describe the role and purpose of EIA for decision-making;
- Outline the strengths and limitations of EIA ;
- Explain the use of Impact identification and evaluation methods in EIA;
- Outline the format of an EIA Report;
- Explain the purpose of monitoring or audits;
- Explain the relationship between planning and EIA;
- Discuss the role of EIA and Strategic Environmental Assessments (SEA) in contributing to sustainable development
- Plan and carrying out an EIA
- Critically asses an EIA report

Mode of delivery/teaching

The course shall be conducted through lectures, case studies and site visits.

Mode of Assessment

Assessment will be done through course works (Take home essay, time essay and test) and a final written examination. Coursework will carry a total of 40% and final examination will carry 60% of the final grade mark.

Proposed Staff

Dr. Charles Niwagaba
Prof. Frank Kansiime
Herbert M. Kalibbala

Reading/Reference Materials

UNEP. (1998). *Environmental Impact Assessment Training Manual*.

African Development Bank. (2003). *Integrated Environmental and Social Impact* assessment Guidelines.

Government of Uganda. (1997). *Guidelines for Environmental Impact Assessment in Uganda*.

Government of Uganda. (1998. *The Environmental Impact Assessment Regulations for Uganda.*

UNEP. (1996). *Environmental Impact Assessment: Issues, Trends and Practice*

Cahill, L.B and Kane R.W. (1987). *Environmental Audits*. Government Institutes, Inc.

Knaussenberger. W.I, Booth G.A, Bingham C.S and Gaudet. J.J (eds). (1996). *Environmental Guidelines for small-scale Activities in Africa. Environmentally sound design for planning and implementing humanitarian and development*

6.3.12 CIV8112 Water Transport and Distribution (3 CU)

Course Description

The course covers introduction to water transport and distribution, pumping stations, Unaccounted for water and leakage, urban water demand planning and management as well as water supply

from the roof tanks.

Objectives

The main objective of this course is to introduce the basics of planning, hydraulic and engineering design, construction, operation and maintenance of water transport and distribution systems.

The specific objectives are to enable students to:

- describe the main planning elements of water transmission and distributions systems, namely determining demands, pressures, velocities and gradients
- choose adequate supplying schemes, prepare a network layout with the main components and pipe materials
- distinguish between various operational modes
- judge technical solutions dealing with the system maintenance, rehabilitation, and expansion.

Course Content

1. *Introduction* ***(5CH)***

1.1 Main objectives and components of water transport and distribution systems.

1.2 Water demand: categories, patterns, calculation, forecasting.

2. *Hydraulics of pressurised flows* ***(25CH)***

2.1 Basic equations, single pipe calculation, branched and looped networks, system- and pump characteristics, pressure related demand; hydraulics of storage and pumps

2.2 Main components of hydraulic design: design parameters, choice of supply scheme, network layouts.

2.3 Engineering design: choice of pipe materials, valves and other equipment.

2.4 Network construction: pipe laying, testing and disinfection.

3. *Pumping stations* ***(12CH)***

3.1 Review of various pumps and their applications,

3.2 Design of pumping stations,

3.3 Power requirements and energy consumption

3.4 Auxiliary equipment.

4. *Operation and maintenance* ***(10CH)***

4.1 Regular and irregular supply

4.2 Unaccounted-for water definition,

4.3 Leak detection methods

4.4 Network cleaning and rehabilitation procedures

4.5 Water demand planning and management measures.

5. *Roof tanks* ***(8CH)***

4.1 Applications in water scarce areas,

4.2 Hydraulic operation, design, construction and maintenance.

Learning Outcomes

On completing the course, students should be able:

- § to decide on the main planning elements of water transmission and distribution systems, namely designing demands, pressures, velocities and gradients
- § to fully understand the steady-state hydraulics and thereby use the knowledge to choose adequate supplying schemes, suggest a network layout, main components and pipe materials,
- § to distinguish between various operational modes and judge technical solutions dealing with the system maintenance, rehabilitation, and expansion.

Mode of teaching/delivery
The course shall be conducted through lectures, tutorials and study tours/field visits. Course delivery will be by use of state-of-the-art methods using power point presentations and student centred/learner-centred methods pedagogy.

Mode of Assessment
Assessment will be done through continuous interim assessments (assignments, quizzes/tests, field study reports) and a final examination. Interim assessment will carry a total of 40% and final examination will carry 60% of the final grade mark.

Proposed Staff
Herbert M. Kalibbala

Reading/Reference Materials
Bauman, D.D., Boland, J.J., Hanemann, W.M. 1998. *Urban Water Demand Management and Planning*, McGraw-Hill.

Bhave, P.R. 1991. *Analysis of Flow in Water Distribution Networks*. Technomic Publishing Co. Inc.

Brandon, T.W. 1984. *Water Distribution Systems*. The Institution of Water Engineers and Scientists.

Holzenberger, K., Jung, K. 1990. *Centrifugal Pump* - Lexicon, 3rd edition. KSB.

Huben von, H. 1996. *Water Transmission and Distribution*. AWWA.

Mays, L.W.1999. *Water Distribution Systems Handbook*. McGraw-Hill.

Sanks, R.L.1998. *Pumping Station Design*. Butterworth-Heinemann.

Smith, L.A., Fields, K.A., Chen, A.S.C., Tafuri, A.N. 2000. *Options for Leak and Break Detection and Repair for Drinking Water Systems*. Battelle Press.

Haestad Methods (Author), Donald V. Chase (Author), Dragan A. Savic (Author), Thomas M. Walski (Author). *Water Distribution Modeling*.

Haestad Methods (Author), Thomas M. Walski (Author), Donald V. Chase (Author), Dragan A. Savic (Author), Walter M. Grayman (Author), Stephen Beckwith (Author), Edmundo Koelle (Author) *Advanced Water Distribution Modeling and Management*.

Trifunovic, N. 2006. *Introduction to Urban Water Distribution*. UNESCO-IHE Lecture Note Series. Taylor & Francis – 528 pages.

6.3.13 CIV8113 Planning for Community Water Supply and Waste Management (3 CU)

Course Description
The course covers water supply and sanitation development planning, community waste management, management of waste supply and waste disposal projects. The course includes case

studies on related issues and study visits to community water supply projects, water purification plants and laboratories, waste transfer centers, disposal sites and treatment systems.

Objectives

This course aims to enhance the knowledge and capability of graduate students in the planning, designing and managing community water supply and waste disposal systems.

The specific objectives are to enable students to:

- describe the various planning tools for use in the initiation of community water supply and waste management projects,
- design sustainable community water supply and waste management projects taking into account the community views and interests.

Course Content

1. *Water supply and sanitation development planning* *(10CH)*

1.1 Issues of community environment, sanitation and health
1.2 Urbanization and population studies for water supply and waste management planning
1.3 Planning for community water supply and waste management projects, *e.g.* household environmental sanitation (HCES) approach and other bottom-up planning approaches Vs top-down planning approaches

2. *Community wastes management* *(20CH)*

2.1 Solid waste: sources, and characterization
2.2 Planning for solid waste collection and disposal assessment systems
2.3 Solid wastes management alternatives and environmental and financial implications
2.4 Site specification and evaluation of landfill operation
2.5 Wastewater: collection and treatment systems
2.6 Low cost treatment techniques
2.7 Hazardous wastes issues.

3. *Management of water supply and waste disposal projects* *(15CH)*

3.1 Project management concept
3.2 Financial management for community water supply and waste disposal projects
3.3 Development of community/ private sector participation in waste management.

4. *Case studies and study visits* *(10CH)*

a. Case studies on development planning and designing of water supply systems for small and medium communities
b. Management practices for solid waste collection and disposal including sanitary landfill
c. Incineration, waste reduction and recycling programs
d. Community wastewater collection and treatment systems

5. *Study visits to water supply and waste management projects of small and medium communities in various parts of the country* *(5CH)*

Learning Outcomes

On completing the course the student should be able to:

- § describe the various planning tools for use in the initiation of community water supply and waste management projects with a focus on ensuring sustainability of the projects,
- § facilitate the planning and design of sustainable community water supply and waste management projects taking into account the community views and interests.

Mode of teaching/delivery

The course shall be conducted through lectures, tutorials and study tours/field visits. Course delivery will be by use of state-of-the-art methods using power point presentations and student centred/learner-centred methods pedagogy.

Mode of Assessment

Assessment will be done through continuous interim assessments (assignments, quizzes/tests, field study reports) and a final examination. Interim assessment will carry a total of 40% and final examination will carry 60% of the final grade mark.

Proposed Staff

Dr. Charles Niwagaba

Dr. Robinah Kulabako

Reading/Reference Materials

Ali, M. (Ed.) 2004. *Sustainable Composting. Case studies and guidelines for developing countries*. The Water Engineering and Development Center (WEDC), Loughborough University, Leicestershire, UK. ISBN 1 84380 071 3.

BORDA, 2009. *Decentralised wastewater treatment systems (DEWATS) and sanitation in developing countries. A practical guide*. Bremen Overseas Research and Development Association. Published by WEDC, Loughborough University, UK.

Lüthi, C., Panesar, A., Schütze, T., Norström, A., McConville, J., Parkinson, J., Saywell, D., Ingle, R. 2011. *Sustainable Sanitation in Cities – A Framework for Action*. Sustainable Sanitation Alliaance (SuSanA) & International Forum on Urbanisation (IFoU), Papiroz Publishing House, The Netherlands. ISBN 978-90-814088-4-4.

Peal, A., Evans, B., Van Der Voorden, C. 2010. *Introduction to hygiene and sanitation software: A selection of approaches*.

Tayler, K., Parkinson, J., Colin, J. 2003. *Urban Sanitation: A Guide to strategic Planning*. ITDG Publishing Rugby, UK.

Tchobanoglous G. and Kreith F. (2002). *Handbook of Solid Waste Management*. Second Edition. McGraw-Hill Handbooks. ISBN 0-07-135623-1. 6.

Van Vliet, B., Spaargaren, G., Oosterveer, P (Eds.). *Social perspectives on the sanitation challenge*. Springer Science and Business Media.

6.3.14 CIV8114 Groundwater Modelling (3 CU)

Course Description

The goal of the course is to teach the students how to use professional software for the simulation and prediction of groundwater flow and pollutant transport, such that they are able to analyse and solve any groundwater problem that they would encounter in their professional career. In addition, the students should be able to transform the field data into model inputs, estimate or approximate

missing data, select the appropriate modelling tools, set up a numerical model, select appropriate boundary conditions, solve problems numerically, analyze convergence and stability criteria, interpret modelling results in the correct way, and present results by a professional report and oral presentation.

Objectives

The course is intended to enable the student to:

- Select and apply different software tools for the solution of groundwater problems
- Collect and process groundwater field data

Course Content

1. Introduction to groundwater modelling mathematics, basic parameters and variables, continuity equation, momentum equation, flow equations for different conditions, boundary conditions, approximate groundwater flow equations ***(10CH)***

2. Numerical techniques for groundwater modelling: steady and transient flow, numerical approximation of boundary conditions, matrix inversion techniques and iterative solvers, linear and non-linear problems, stability and convergence criteria ***(10CH)***

3. Numerical techniques for groundwater pollution modelling: numerical approximation of transport and dispersion for simulation of groundwater pollution, boundary conditions, flow tracking, numerical solvers, stability and convergence criteria, influence of sorption and decay processes ***(10CH)***

4. Laboratory practice - Hands-on computer introduction to the MODFLOW (or some other) model: grid design, input of aquifer characteristics and boundary conditions, choice of solvers and stopping criteria, output facilities and graphical representation of results ***(15CH)***

Learning Outcomes

On completing the course the student should be able to:

- § Process raw groundwater data using state-of-the-art techniques
- § Understand the factors used in the selection of models for groundwater and their limitations
- § Use advanced hydrological models for solving groundwater problems

Mode of teaching/delivery

The course shall be conducted through lectures, practicals and tutorials.

Mode of Assessment

Assessment will be done through continuous interim assessments (assignments, practicals and tests) and a final examination. Interim assessment will carry a total of 40% and final examination will carry 60% of the final grade mark.

Proposed Staff

Dr. Ben Mangeni
Dr. A. Rugumayo
Dr. Robinah Kulabako

Reading/Reference Materials

Hydrology in Practice, Elizabeth M. Shaw et al., 4th Edition

Applied Groundwater Modeling (Mary P. Anderson and William W. Woessner)

Fetter C.W. (2001). *Applied Hydrogeology*, 4th Edition. Prentice Hall, Inc. ISBN 0-13-088239-1

Neven Kresic (2007). *Hydrogeology and Groundwater Modeling*, 2nd Edition. CRC Press. ISBN-13:978-0-8493-3348-4

6.3.15 CIV8115 Environment and Development (3 CU)

Course Description

This course will introduce students to challenges associated with development and environment in Uganda and world over. The course will help students to analyze issues related to economic growth and development, population growth and need for sustainable development. Students will be able to formulate practical policy responses to the emerging environment vis-à-vis development issues for sustainable development planning. This course will cover a series of development related environmental challenges and will expose students to key issues in the major development areas of concern such as industrialization, urbanization and agriculture and their impact on environment and topical issues like education for sustainable development and millennium development goals.

Objectives

- Introduce the relationship between environment management and development
- Explore alternative approaches to development that are environmentally friendly
- Demonstrate different development activities and their impacts on the environment
- Explain the, policy and political implications related to development policy and practice and how they impact on the environment and natural resource therein.
- Introduce the different development sectors such as urbanization, agriculture, industrialization, and trade and how they impact on the environment and suggest ways to mitigate the impacts.
- Elucidate the importance of pre-project environmental assessments in development and environmental sustainability.
- Discuss the role of NGOs, civil society organizations in fostering social responsibility in the emerging environmental management issues

Course Outline

1. ***Overview of Environment and development*:** Development and environment: Historical background; Environmental philosophies: Eco-centrism and Techno-centrism; Environmental trends and challenges for developing countries; The global debate; Rich and Poor countries: Similar concerns, differing priorities; Traditional vs. alternative development approaches and Ecological concepts and principles for development, Millennium development goals (MDGs), contribution of natural resources to attainment of MGDS; women and environment; towards gender mainstreaming in environmental policies.
2. ***Development and the Environment: The challenge*:** The context: population, poverty and economic growth; Sustaining development; Development sectors and related environmental impacts; Environmental priorities for development; Development vs. environment and natural resource conservation in developed and developing countries; The concept of sustainable development; Markets, governments and environment, education for sustainable development, poverty, environment and development

3. **Environments and Development: The Ugandan Situation:** Environmental management trends in Uganda; Environment: policy, governance for Uganda; Environment, poverty, environment and development in Uganda; Challenges for ensuring development and environmental management in Uganda, District Action planning and natural resources planning in Uganda
4. **Environment and Development: Development planning:** Building on the concept of sustainable development; The Eco-development approach; Eco-development planning; Eco-strategies and techniques; The relevance of environmental assessments for development projects; The role of NGOs and civil society in environmental management
5. **Making better decisions: information, institutions and participation:** Political economy of environmental degradation, Improving knowledge and understanding, Changing institutions: making the public sector more responsive, Involving local people, Negotiating and conflict resolution; Lobbying and advocacy

Learning Outcomes

By the end of the course students should be able to:

- Critically review traditional approaches to development and explore alternative approaches to development that are environmentally friendly
- Discuss different development activities and how they impact on the environment
- Explain why development and environmental management should go hand in hand
- Describe the, policy and political implications related to development policy and practice and how they impact on the environment and natural resource therein.
- Discuss different development sectors such as urbanization, agriculture, industrialization, and trade and how they impact on the environment and suggest ways to mitigate the impacts.
- Describe the importance of pre-project environmental assessments in development and environmental sustainability.
- Analyze the role of NGOs, civil society organizations in fostering social responsibility in the emerging environmental management issues
- Formulate practical policy responses to the emerging environment vis-à-vis development issues for sustainable development planning.

Mode of delivery/Teaching

The course shall be conducted through lectures and discussions, student desk-research and seminar presentations, student-led discussion topics and role play (students play different roles as environmental conservationists and developers and each defends his/her role).

Mode of Assessment

Assessment will be done through course works (Take home essay, time essay and test), student presentations and a final written examination. Coursework and student presentations will carry a total of 40% and final examination will carry 60% of the final grade mark.

Proposed Staff

Staff from the Department of Environmental Management, College of Agricultural and Environmental Sciences

Reading/Reference Materials

Bartelmus, P (1986). *Environment and development*. Allen and Unwic Inc. London, UK

Dooge J.C.I. and Goodman G.T (1992). *An agenda for environment and development into the 21st century*. Cambridge University Press

UNEP (1981). *Environment and development in Africa*. Pergamon press

Johns A. D. (1989). *Conservation for development*. Longman group, London

Kerry, R. T. (1980). *Sustainable environmental management: Principles and practices*. West view press

Kanchan, C., Kadekodi, G, K. and Murty M.N. (1990). *Participatory Development: People and common property resources*. Sage Publications Ltd.

United Nations Development Programme (2007). *Global Environmental outlook. 4,* Progress Press Ltd, Malta

6.3.16 CIV8116 Environmental Health and Waste Management (3CU)

Course Description

This course will introduce students to the concepts in environmental health and shall cover a discussion of environmental health problems in Uganda, the region and worldwide. The course shall explore the use of tools of toxicology, epidemiology and social science and case studies of pollution in different media (air, water and soil etc) shall be assessed, chemicals and pesticides, epidemics and food borne illness, the impact of climate change on environment shall also be discussed. It will include environmental diseases, emerging and re-emerging zoonoses and communicable wildlife diseases. The course shall analyze urbanization, industrialization and related environmental hazards, environmental pollution, solid and hazardous waste management, public health policy and agencies involved in environmental health. The course will be suitable for students who wish to gain a basic understanding of in environmental health, with cases of more detailed investigation of specific concepts.

Objectives

- Introduce the major environmental health issues facing Uganda and the world
- Provide the status of our global environmental health
- Create an understanding of the basic concepts of environmental health
- Introduce the basic terms and concepts as they relate to global environmental health:
- Discuss the common environmental hazards that pose risks to human health and safety.
- Discuss and predict global human population numbers and the impact on our global environmental health
- Describe and influence regulatory policies, guidelines and authorities that control environmental health issues
- Identify individual and human behaviours that foster or hinder the well-being of our global environmental health

Course Outline

1. Introduction to Environmental Health,
2. Health problems related to poor housing, poor water supply, and poor human waste disposal and refuse disposal systems
3. Population Control (family planning, birth control and health impacts)
4. Impacts of Growth on Ecosystems (degradation of land resources, loss of biodiversity)

5. Food and water borne diseases
6. Environmental Disease (mutation, birth defects, cancer, zoonoses) and toxic substances (PCBs, dioxin, asbestos, lead, mercury)
7. Re-emerging and emerging zoonoses, wildlife diseases; impact and control strategise
8. Occupational health
9. Risk assessment and management
10. Environmental health hazards: Pesticides; Radiation;
11. Urbanization, Industrialization and associated environmental health hazards.
12. Environmental pollution: air pollution; noise pollution; and water pollution
13. Sanitation; water supply and water treatment, excreta disposal, drainage, vector control,
14. Hygiene promotion
15. Solid and Hazardous Waste management; waste disposal history, municipal solid waste, current waste disposal alternatives, hazardous wastes, waste management options, legislation
16. Public health policy, community and other public health legislation.
17. Agencies involved in environmental health and protection of the public

Learning Outcomes

By the end of this course the student shall be able to:

- Discuss the major environmental health issues facing Uganda and the world
- Discuss the status of our global environmental health
- Articulate basic concepts of environmental health
- Discuss the basic terms and concepts as they relate to global environmental health:
- Discuss the common environmental hazards that pose risks to human health and safety.
- Discuss and predict global human population numbers and the impact on our global environmental health
- Describe and influence regulatory policies, guidelines and authorities that control environmental health issues
- Identify individual and human behaviours that foster or hinder the well-being of our global environmental health

Mode of delivery/Teaching

The course shall be conducted through lectures and discussions, student desk-research and seminar presentations, student-led discussion topics.

Mode of Assessment

Assessment will be done through course works (Take home essay, time essay and test), student presentations, practicals, field reports, student presentations and a final written examination. The interim assessments will carry a total of 40% and final examination will carry 60% of the final grade mark.

Proposed Staff

Dr. Robinah Kulabako & Staff from the Department of Environmental Management, College of Agricultural and Environmental Sciences

Reading/Reference Materials

Blumenthal, D. S., and Ruttenber, A. J. (1995). *Introduction to environmental health.* Second Edition. New York: Springer

Moeller, D. W. (1992): *Environment Health.* Harvard University Press.

Creager, J. (1993): *Basic Health Science Chemistry: A review and workbook.* Wm. C. Brown Publishers

Forbes V.E. and Forbes T.L. (1994): *Ecotoxicology in theory & Practice*. Chapman & Hall

Dudlex, N. (1991): *Good Health on a Polluted planet: A handbook of environmental hazards & how to avoid them.* Thorsons Publishers

Train, R. E. (1990): "Environmental concerns for the year 2000" The Bridge.

6.3.17 CIV8117 Integrated Water Resources Management (3 CU)

Course Description

The course introduces students to Integrated Water Resources Management (IWRM). The purpose of this course is to give the students of water resources management a wider understanding of IWRM and the procedures and tools available for its implementation.

Objectives

- Introduce the basic principles and practice of IWRM;
- Analyse the functions of natural and anthropogenic factors in water resources management
- Create an appreciation of water conservation and management interactions;
- Introduce transboundary issues in water resources management
- Create an understanding of water as a social and economic good
- Enhance student's capacity to plan water resource development
- Provide an understanding of principles of catchment management including policies, strategies and institutional arrangements for IWRM
- Introduce measures to protect water resources including laws and regulations governing water resources

Course Outline

1. Surface Water and Groundwater sources (to understand the different types of water sources)
2. The nature and characteristics of groundwater, surface water, river, and wetland water resources (the physical, chemical and biotic nature of water sources)
3. Factors that affect the use of water resources (demand, availability, quality, quantity)
4. Water pollution and impact on water quality and health (point and diffuse pollution sources, natural and anthropogenic pollution, nature of pollution, effects on water sources and water uses)
5. Climate change and water resources (explain the impact of climate change on water resources)
6. Management of the Water Resources (Water catchment management, water conservation, strategic planning of water resources at national, regional and local levels to meet user demand, environmental protection and sustainable management needs)
7. Policies, goals , strategies and Institutional Arrangement for IWRM (National and transboundary considerations)
8. The management of water abstraction, the licensing process, consultation procedures, enforcement

9. The threats to the quality of water resources, the identification of risk and the measures taken to protect them (water conservation, water treatment and wastewater treatment. Laws, standards and their implementation)

Learning Outcomes

By the end of the course, students should be able to:

- § Explain the basic principles and practice of IWRM;
- § Asses the role of natural and anthropogenic factors in water resources management
- § Understand water demand/use and management interactions;
- § Discuss the role of Water Conservation, Treatment and Reuse
- § Discuss transboundary issues in water resources management
- § Explain water as a social and economic good
- § Plan water resource development
- § Explain the principles of catchment management
- § Explain policies, strategies and institutional arrangements for IWRM
- § Explain measures to protect water resources including laws and regulations governing water resources
- § Critically appraise the existing procedures for water resources management and suggest improvements

Mode of delivery/Teaching

The course shall be conducted through lectures and discussions, field visits and practical sessions.

Mode of Assessment

Assessment will be done through continuous interim assessments (course work-take home essays, timed essays and test, practicals and field reports) and a final written examination. Interim assessment will carry a total of 40% and final examination will carry 60% of the final grade mark.

Proposed Staff

Dr. Albert Rugumayo and members of staff from the Department of Environmental Management, College of Agricultural and Environmental Health Sciences.

Reading/Reference Materials

McDonald, A.T and Kay, D (1998). *Water Resources: Issues and Strategies*. Longman Scientific and Technical.

Chapman, D. (1992). *Water management and Environmental Engineering*. Chapman and Hall.

Feachem, R, McGarry, M. and Mara, D (1977). *Water, Wastes and Health in Hot Climates*. Wiley.

*The World Ban*k, Washington, D.C *(2000) Water Resources Management, A World Bank Policy Paper,* Global Water Partnership.

UN-ESCAP (1996). *Integrated Water Resources Management, TAC Background Papers No. 4,* Global Water Partnership Technical Advisory Committee, Sweden.

Morgan, P. (1990). *Rural Water Supply and Sanitation.* McMillan.

Global Water Partnership, 2000. *Integrated Water Resources Management. TAC Background Papers, no 4*, 67 pp. www.gwpforum.org/gwp/library/Tacno4.pdf

Global Water Partnership, 2002. Toolbox, Integrated Water Resources Management. http://gwpforum.netmasters05.netmasters.nl/en/index.html

6.3.18 CIV8118 Irrigation design and management (3 CU)

Course Description

The chief objective of the workshop is to provide techniques, calculation procedures and software packages which are helpful for the proper design, operation and management of irrigation schemes, and this for conditions of unlimited and limited water supply. A proper operation can, given the constraints of the physical infrastructure, results in a saving of considerable volumes of irrigation water and an overall improvement of the performance and water productivity of the system (more crops per drop). The students will also be exposed to the design and operation of water distribution networks, the structures to control and manage the water distribution, and the monitoring of the water distribution.

Objectives

The course is intended to provide the student with:

- An understanding of the processes involved in designing irrigation systems
- In-depth understanding of the global significance of irrigation for food security
- Skills and tools for designing the component of irrigation systems
- The processes and tools for proper management of irrigation systems

Course Content

1. *Irrigation design*

1.1 Field design of irrigation systems ***(8CH)***

Design and modelling of surface irrigation systems (basin, border and furrow)
Design of sprinkler irrigation systems (hand-move, mechanical systems, center pivots linear-move irrigation systems, LEPA irrigation and precision irrigation developments);
Design of micro-irrigation systems (surface drip and sub-surface drip systems; control and automation devices in micro-irrigation systems)

2.1 Monitoring of the irrigation performance at the field level (indicators, assessment of the design performance of surface and pressurized systems ***(5CH)***

3.1 Design and modelling of subsurface drainage systems (steady and unsteady equations/criteria for groundwater table and salinity control and as sub-irrigation system) ***(5CH)***

2. *Irrigation management*

2.1 Planning the operation ***(6CH)***

Preparation of 'Irrigation Plans' to match supply with demand as closely as possible for different type of irrigation schemes. Development of an irrigation plan that provides information to the Irrigation supervisor for various weather conditions:

- Development of an irrigation plan for a multicrop system
- Development of an irrigation plan for a rice scheme
- Design of the rotational delivery of irrigation water in block of fields

2.2 Operation of irrigation systems ***(3CH)***

Efficient distribution of irrigation water supplies:

- Required hydraulic infrastructure to control the water flow in the canal network
- Type, function and place of the hydraulic structures
- Matching supply with demand in an irrigation scheme

2.3 Monitoring the water supply and performance of the system: ***(3CH)***
- At scheme level: Collecting information at short (ongoing season) and long (forthcoming seasons) term; and
- At field level: Efficiency and uniformity performance indices.

3. Laboratory/Field practice ***(15CH)***

Learning Outcomes

On completing the course the student should be able to:

- § Design irrigation systems of various types
- § Plan and operate existing systems

Mode of teaching/delivery

The course shall be conducted through lectures, tutorials, and practicals.

Mode of Assessment

Assessment will be done through continuous interim assessments (assignments, practicals and tests) and a final examination. Interim assessment will carry a total of 40% and final examination will carry 60% of the final grade mark.

Proposed Staff

Dr. Albert I. Rugumayo

Dr. Ben Mangeni

Reading/Reference Materials

Irrigation Engineering by Sharma R. K. Publisher – S Chand Group

Hydrology in Practice, Elizabeth M. Shaw et al., 4th Edition

6.3.19 CIV8119 Hydropower Planning and Design (3 CU)

Course Description

This course provides the fundamentals for hydropower production. The course includes an overview of hydrology and physics of hydropower engineering, power, head, and flow-rate. In addition, the course covers traditional system components including spillways, gates, valves, trashracks, penstocks, generators, hydro batteries, and governors.

Objectives

The course is intended to enable the student to:

- Design hydropower systems including their components
- Model energy and power production for existing and planned hydropower systems
- Understand the process involved in planning and design of hydropower projects of various sizes

Course Content

Introduction to hydropower engineering, types of hydropower systems, design of hydropower systems, turbines, penstocks, spillwaysgates, valves, generators. Dam and reservoir design, Earth dams, Gravity dams, turbine types. Power modeling. Seasonal power analysis. Micro- Mini- and Large Hydro. Renewable energy. Planning hydropower systems. Planning small and large hydropower. Financing of hydropower projects. Environmental issues ***(30CH)***

Laboratory work (Practice with different software tools for designing hydropower systems and hydropower modelling) ***(15CH)***

Learning Outcomes
On completing the course the student should be able to:

- § Design hydropower systems
- § Understand the factors that are important in planning and implementing hydropower projects

Mode of teaching/delivery
The course shall be conducted through lectures, practicals and tutorials.

Mode of Assessment
Assessment will be done through continuous interim assessments (assignments, practicals and tests) and a final examination. Interim assessment will carry a total of 40% and final examination will carry 60% of the final grade mark.

Proposed Staff
Dr. Albert Rugumayo
Mr. Michael Kizza

Reading/Reference Materials
Hydropower Engineering Handbook by John S. Gulliver, Roger E. A. Arndt. McGraw Hill (1990)
Hydropower Engineering by C. C. Warnick. Prentice Hill

6.3.20 CIV8120 Water Resources Project Planning (3 CU)

Course Description
The course provides students with techniques and tools for successfully planning and implementing water resources projects. The students will get knowledge about the differences in implementation processes for small and large projects, single purpose and multipurpose projects. In addition, students will be able to understand the legal, institutional, financial, environmental and political constraints on the planning of water resources projects

Objectives
The course is intended to enable the student to:

- Understand the processes involved in planning and implementing water resources projects
- Prepare water resources project planning and implementation plans

Course Content
Formulation, planning and execution of water resources development projects. Implementation and evaluation scheduling. Cost allocation. Single- and multi-purpose projects. Water law of Uganda and national water policy. Finance legislation and management services. Functions of government and other agencies in water management. Consulting, contracting and management services. Compatibility of various water uses. ***(45CH)***

Learning Outcomes
On completing the course the student should be able to:

- § Plan, manage and execute water projects

§ Review water projects for conformity with legal and environmental requirements

Mode of teaching/delivery
The course shall be conducted through lectures, tutorials.

Mode of Assessment
Assessment will be done through continuous interim assessments (assignments, practicals and tests) and a final examination. Interim assessment will carry a total of 40% and final examination will carry 60% of the final grade mark.

Proposed Staff
Dr. Albert Rugumayo
Mr. Michael Kizza

Reading/Reference Materials
Water Resources Planning (3rd Edition) - Andrew A. Dzurik (Author), Publisher**:** Rowman & Littlefield Publishers (2002)

7. Resources and Infrastructure

7.1 Source of Funds

The primary source of funds to run the programme shall be obtained from tuition fees paid by the Graduate students.

7.2 Staff

The Department has staff members (at the position of lecturer and above) that with the help of other members of staff who assist, are sufficient to handle the courses under the programme. Where need arises, staff from other units of the University and part-time staff (in exceptional circumstances) are planned to be engaged in the teaching. The detailed list of staff is given in Appendix A & B.

7.3 Facilities

The Department, under the Faculty of Technology is housed in the old Faculty of Technology Building with additional laboratory and office space in the New Faculty of Technology extension (Environmental Engineering). Details of the available infrastructure within the Department are presented in Appendix C.

Appendix A. Departmental Academic Staff List

SN	Name	Highest Qualification	Full or Part time	Field of Specialization	Academic Rank
1	J. A. Mwakali	PhD	Full-time	Structures	Professor
2	N. G. Katashaya	PhD	Full-time	Water Resources Engineering	Professor
3	U. Bagampadde	PhD	Full-time	Highway Engineering	Sen. Lecturer
4	Y. Nakuziraba	PhD	Full-time	Structures	Sen. Lecturer
5	B. Mangeni	PhD	Full-time	Water Resources Eng.	Lecturer
6	D. Kalumba	PhD	Full-time	Geotechnical Engineering,	Lecturer
7	M. Kigobe	PhD	Full-time	Water Resources Engineering	Lecturer
8	C. Niwagaba	PhD	Full-time	Public Health/ Environmental Engineering	Lecturer
9	R. Kulabako	PhD	Full-time	Public Health/ Environmental Engineering	Lecturer
10	A. Rugumayo	PhD	Part-time	Water Resources Eng.	Lecturer

Appendix B. Full Time Staff who assist on the programme

SN	Name	Highest Qualification	Full or Part time	Field of Specialization	Academic Rank
1	P. Mujugumbya	MSc	Full-time	Structures	Lecturer
2	H. Kalibbala	MSc	Full-time	Public Health/ Environmental Engineering	Assist. Lec.
3	M. Kizza	MSc	Full-time	Water Resources Engineering	Assist. Lec.
4	M. Matovu	MSc	Full-time	Structures	Assist. Lec.
5	J. Semuwemba	MSc	Full-time	Public Health/ Environmental Engineering	Assist. Lec.
6	M. Tumutungire	MSc	Full-time	Water Resources Eng.	Assist. Lec.
7	M. Namutebi	MSc	Full-time	Highway Engineering	Assist. Lec.
8	P. Musaasizi	MSc	Part-time	ICT and Eng. Mathematics	Assist. Lec.
9	A. Buryegyeya	MSc	Full-time	Water Resources Eng.	Assist. Lec
10	R. Kizza	MSc	Full-time	Geotechnical Engineering	Assist. Lec
11	G. Mwesige	MSc	Full-time	Highway/Transportation Engineering	Assist. Lec.
12	J. Semuwemba	MSc	Full-time	Public Health/ Environmental Engineering	Assist. Lec.
13	G. Kasangaki	BSc, MSc	Full-time	Geotechnical Engineering	Assist. Lec.

Appendix C. Lecture and Laboratory space

Infrastructure item	Number of rooms	Area Coverage (m^2)	Comments
Lecture room space	4	300	Additional space to be acquired in the new building
Soil Mechanics Lab	1	180	New Equipment to be acquired through the Presidential Pledge Initiative
Materials Lab	1	140	New Equipment to be acquired through the Presidential Pledge Initiative
Hydraulics Lab	1	140	New Equipment to be acquired through the Presidential Pledge Initiative
Public Health and Environmental Engineering Lab	1	160	Some state of the art equipment available with some few still needed. This is to be acquired through the Presidential Pledge Initiative, Millennium Science Initiative and development Partners (Sida, Italian Cooperation).
Computer Lab (School of Engineering)	1	60	80 computers, available and over 100 m^2 needed. Additional space will be available in the new building.
E-Lab (School of Engineering)	1	60	50 computers, 1 LCD projector
Office space	8	450	Quite sufficient