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## **MINISTRY OF EDUCATION**

Identified Competency Focus Area and Core Courses for Ethiopian  
Higher Education Institutions Exit Examination

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Program: Bachelor of Science degree in Hydraulic and Water  
Resources Engineering

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## **1. Introduction**

Hydraulic and Water Resources Engineering is a study field that deals with collecting and distributing water where and when it's needed, while protecting the population, industry, environment, infrastructure from harmful excessive water. That means, Hydraulic and water resources engineering activities are related to water supply and wastewater (sewer) systems, irrigation and drainage systems, river training and flood protection works, dams and reservoirs for hydropower generation, water supply and irrigation purposes. Hydraulic and water resources engineering also deals with harbors and ports, as well as river and canal navigation systems.

Undergraduate studies offer a series of basic and applied courses in the area of hydraulic, water resources and environmental engineering (fluid mechanics, hydraulics, hydrology, ground waters, hydro-informatics, water supply and wastewater systems, irrigations and drainage, river hydraulics, sedimentation, river-training works, flood protection, wastewater treatment etc.). The program also offers a broad general civil engineering education, which includes elements of geo-mechanical engineering, structural engineering, construction engineering, materials engineering, transportation engineering, geodesic surveying and geology.

The BSc curriculum of Hydraulic and Water Resources Engineering was designed in such a way that the students' performance, skill and attitude are evaluated at the course level. But, such assessment method needs mapping with program learning outcomes to assess the overall competence of the graduates. Therefore, additional learning outcome measurement techniques have to be set. In this regard, higher education institutions offering this program and other concerned organizations (professional associations) have to develop, validate, and standardize assessment instruments that can directly measure students' achievement of program learning outcomes. The most accepted assessment tool is exit exams.

### **1.1. Objective of the exit exam**

The national public administration exit exam shall have the following objectives

- To produce skilled and competent manpower to national and international market

- Assessing students' educational achievement in major areas of Hydraulic and Water Resources Engineering (HWRE)
- Ensuring whether the graduation profile of HWRE curriculum have achieved at least common standards of knowledge and practical skills
- Improving public trust and confidence in HWRE professionals
- Facilitating the efforts of students to revise the core learning outcomes of the courses covered by the exit examination
- Ensuring all graduates from HEIs satisfy the requirements of the labor market and employability through the national wide implementation of competency-based exit exam
- Creating competitive spirit among HWRE faculties/departments in Ethiopia with the vies to encouraging them to give due attention to the national standards

## **1.2. Significance of the document**

It is important to set competency areas of the subject matter (program) in order to measure the how much graduates are acquired with skills, knowledge and attitudes. The following shows us the significance or setting competencies and identifying core courses of the program;

- To set competencies that helps to assess the basic skills, knowledge and attitude of graduating students
- To systematically identify the core courses which will be included the exit exam

## **2. Expected profiles of graduates**

This program is aimed at training manpower required for the realization of the country's vast hydropower and water resources potential. Well-qualified Hydraulic Engineers will be produced through this program who can actively be engaged in the planning; design; development and management of water resources projects in general. Specifically, the trainees will be equipped with the knowledge that enables them to execute the following tasks:

- Undertake project identification; pre-feasibility and feasibility studies of water resources projects.
- Plan water resources and hydropower projects; design hydraulic structures required for hydropower systems, water supply systems, Irrigation systems and structures which are related with environmental protection works;

- Prepare complete contract documents for water resources projects like hydropower projects, water supply projects, Irrigation projects, and projects which are related with environmental protection works like wastewater and solid waste management;
- Plan, design, manage and supervise the construction of hydraulic and hydropower structures and related civil engineering works;
- Plan, design, manage, monitor and evaluate the operation and maintenance of hydraulic and hydropower systems;
- Remodeling and rehabilitation of existing irrigation, water supply, hydraulic and hydropower systems.

### **3. Competencies and learning outcomes**

#### **3.1. Competencies**

Upon successful completion of the B.Sc. study programme the graduate of B.Sc. degree in Hydraulic and Water Resources Engineering will have acquired all necessary knowledge, skills, attitude, and capabilities, which enables the degree holder to plan, design, construct and operate facilities and structures for optimum utilization of available water resources for hydropower generation, industrial and domestic water supply systems, irrigation systems, natural water flow control, etc.

##### **3.1.1. Knowledge**

The graduate is expected to know basic concept of

- ✓ Hydraulics,
- ✓ Hydrology,
- ✓ Water supply,
- ✓ Hydropower,
- ✓ Irrigation and
- ✓ Water resources development in general.

##### **3.1.2. Skill**

The graduate is expected to be skilled enough to participate and professionally perform engineering services in the different project phases along the project cycle, including:

- Collect, manipulate and analyse hydro-meteorological data

- Using up-to-date modelling tools to design and analyse water resources projects
- Preparing, reading and interpreting design documents of water resources projects
- Organization of tasks, optimization of resources and scheduling activities.

### **3.1.3. Attitude**

To successfully perform in his/her area of specializations, Hydraulic and water resources engineering graduates have the following (not limited to) behavioral attributes or personality characteristics

- Effectively communicate and express idea with stakeholders at each project phase/cycle
- Take initiation in generating ideas for improvement, takes advantage of opportunities, suggests innovations and be up-to-date.
- Listen actively, accomplish and deliver tasks punctually.
- Able to work under difficult situation and be adapting to changing work environments.
- Believe in teamwork, group decisions and prioritize common goals.

### **3.2. Learning outcomes**

The graduate is expected to be skilled enough to participate and professionally perform engineering services in the different project phases along the project cycle, including:

- Identification of problems, elaborate them technically and economically and come up with feasible solutions.
- Plan, design and analyse various water resources projects.
- On-site survey, preparation of pre-feasibility and detail design specifications of projects.
- Preparation of bills of quantities and construction documents as well as assists in the tender process and contract administration.
- Construction supervision, control and approval of contractors' documents and settlement of claims and disputes.
- Operation, management and long-term quality control of water infrastructure.

#### **4. Selected courses to be included in the exam**

Based on the graduate profile and competence of the program, the following fifteen (15) major courses have been selected from total of 65-70 courses in curriculum (see appendix) for exit examination to evaluate knowledge, skill and attitude of the prospect graduates of Hydraulic and Water Resources Engineering.

1. Hydraulics I
2. Hydraulics II
3. Open Channel Hydraulics
4. Engineering Hydrology
5. Groundwater Engineering
6. Hydraulic Structures I
7. Hydraulic Structures II
8. Hydropower Engineering I
9. Hydropower Engineering II
10. Water Supply & Treatment
11. Irrigation Engineering
12. Water Resources Planning & Management
13. River Engineering and Sediment Transport
14. Construction Materials
15. Construction Planning and Management

The selected courses have been classified into specialization and basic sciences categories. Then after, based on the interrelation of the courses, they were further divided into the following six themes:

1. Fluid Mechanics
2. Hydrology
3. Hydraulic Structures
4. Hydropower Engineering & Hydro-Machines
5. Water, soil and Environmental management
6. Building and Construction Engineering

The detail of the selected courses and thematic area are shown in the following table

Category	Themes	Course Name	ECTS
Field Specific Specialization	Fluid Mechanics	Hydraulics I	5
		Hydraulics II	5
		Open Channel Hydraulics	5
	Hydrology	Engineering Hydrology	5
		Groundwater Engineering	4
	Hydraulic Structures	Hydraulic Structures I	4
		Hydraulic Structures II	4
	Hydropower Eng'g & Hydro-Machines	Hydropower Engineering I	4
		Hydropower Engineering II	5
	Water, soil and Environmental management	Water Supply & Treatment	5
		Irrigation Engineering	4
		Water Resources Planning & Management	4
		River Engineering and Sediment Transport	4
Field Specific Basic Science	Building and Construction Eng'g	Construction Materials	3
		Construction Planning and Management	4

## 5. Conclusion

In addition to course wise learning outcome assessment, it's very important to evaluate graduates knowledge, skill, attitude and overall competencies at program level. To evaluate overall learning outcomes of the BSc in Hydraulic and Water Resources Engineering program, curriculum-based exit exams have to be adopted. Curriculum-based exit exam is important not only to improve the excellence and effectiveness of program, but also to restore education and systems quality in general. Based on this, fifteen core courses have been selected for exit examination from the total of 65-70 courses in the curriculum that the students took in ten semesters (five years) study period.

Managing the exit exam at each level might be a difficult task. Particularly preparing students for the exam due to their personal worries and anxieties is a big challenge especially for the first time as the awareness of the impacts of exit exams are not well known yet. Therefore, working on awareness creation among stakeholders is crucial. Moreover, acceptance, readiness and teaching skills of faculty members may need to be considered as part of the success of the exit exam.

**Appendix:** List of courses in Hydraulic and Water Resources Engineering program and their categories

S.No	Module Category	M.NO	MODULE NAME	CODE	COURSE NAME	Pre-Requisite	COURSE DISTRIBUTION						Total Cr.Hrs	Total ECTs	Number of Courses	Proportion of module Categories	
							Cr. h	L	T	LP	HS	ECTS					
1	None Field Specific	1	Ethics and Language	CEst - 1021	Civic and Ethical Education	None	3	2	3	0	3	5	12	17	4	5	
				HSRL-111	HIV/AIDS, SRH and Life Skills	None	3	2	3	0	3	5					
				EnLa - 1012	Communicative English skill	None	3	3	0	0	3	4					
				EnLa - 1013	Basic Writing Skill	EnLa-1012	3	3	0	0	2	3					
22	None Field Specific	22	Reporting and Entrepreneurship	EnLa-3221	Technical Report writing and Research Methodology	None	1	1	0	1	1	2	3	4	2		16
				Mang - 3222	Entrepreneurship for Engineers	None	2	1	2	0	1	2					
2	Mathematics and Natural Science	2	Basic Engineering skills	GEng-1021	Introduction to Engineering Professions	None	2	3	0	0	3	3	10	18	4	16	
				MEng - 1022	Engineering Drawing	None	3	2	0	3	4	6					
				CENG - 1023	Engineering Mechanics (Statics)	None	3	2	3	0	5	6					
				Comp-1024	Computer Programming	None	2	2	0	2	2	3					
3	None Field Specific	3	General Engineering skills	EENG-2031	Basic Electricity and Electrical Machine	None	2	1	2	1	1	3	3	5	2		16
				MENG-2032	General Workshop Practice	None	1	0	0	3	0	2					
4	None Field Specific	4	Applied	Math -	Applied Mathematics -	None	4	3	3	0	4	6	10	16	3	16	

			Mathematics	1041	I																
				Math-1042	Applied Mathematics-II	Applied Mathematics I	4	3	3	0	4	6									
				Stat-1043	Probability and Statistics	None	2	1	3	0	2	4									
5		5	Advanced Mathematics	Math - 2051	Advanced Maths for Engineers	Applied Mathematics-II	4	3	3	0	4	6	6	10	2						
				Math-2052	Numerical Analysis	Math-1042, Comp-1024	2	1	2	1	2	4									
6		6	Surveying	CENG-1061	Surveying-I	None	3	2	1	2	2	4	7	9	3						
				CENG-2062	Surveying II	Surveying-I	3	2	1	2	2	4									
				CENG-3063	Surveying field Practice	Surveying-II	1	0	0	3	1	1									
7		7	Materials and Structures	CENG-1071	Strength of Materials-I	Engineering Mechanics	3	2	3	0	3	5	9	15	3						
				CENG - 2072	Strength of Materials-II	Strength of Materials-I	3	2	3	0	3	5									
				CENG-2073	Theory of Structures	Strength of Materials-I	3	2	3	0	3	5									
8		8	Soil Mechanics	CENG-2081	Soil Mechanics I	Hydraulics-I	3	2	1	2	3	5	8	12	3						
				CEng-2082	Soil mechanics II	Soil Mechanics I	3	2	1	2	2	4									
				Geol - 2083	Engineering Geology	None	2	1	2	0	2	3									
9		9	Geotechnical Engineering	Geol-4091	Rock Mechanics & Tunneling	Engineering Geology	2	2	1	0	2	3	5	8	2						
				CENG-4092	Foundation Engineering	Soil Mechanics II, Reinforced	3	2	3	0	3	5									

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						Concrete I												
10		10	Building and Construction	CENG-2101	Construction Materials	None	2	1	1	2	1	3	4	6	2			
				CENG - 2102	Building construction	Construction Materials	2	1	0	2	2	3						
11		11	Structural Design	CEng - 3111	Reinforced Concrete Design I	Theory of Structures	3	2	3	0	3	5	6	10	2			
				CEng-3112	Reinforced Concrete Design II	Reinforced Concrete Design I	3	2	3	0	3	5						
12		12	Planning and Design Tools	CEng-5121	Contract Specification and Quantity Surveying	Building Construction	2	1	3	0	1	3	6	11	3			
				CEng - 5122	Construction Planning and Management	Building Construction	2	1	3	0	2	4						
				CEng-5123	Construction Equipment and Methods	Construction Materials	2	1	3	0	2	4						
26		26	Design Tools and Project analysis	Arch - 3261	Architectural Drawing	Engineering Drawing , Building Construction	2	1	0	3	2	4	4	7	2			
				HEng - 3262	Engineering Economics	None	2	1	2	0	2	3						
13	Field Specific Specialization	13	Hydraulics	HENG - 2132	Hydraulics-II	Hydraulics-I	3	2	1	2	3	5	9	15	3			
				HENG - 2133	Open Channel Hydraulics	Hydraulics-II	3	2	3	0	3	5						
				HENG-1131	Hydraulics-I	Engineering Mechanics	3	2	1	2	3	5						
14		14	Hydrology	HENG-2141	Introduction to Hydrology	None	3	2	3	0	2	4	10	15	4			
				HENG-3143	Engineering Hydrology	Introduction to	3	2	3	0	3	5						

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					Hydrology, Probability & statistics												
				HENG-3142	Hydrometry Practice	Introduction to Hydrology	1	0	0	3	1	2					
				HENG - 3144	Ground Water Engineering	Introduction to Hydrology, Hydraulics I	3	2	2	1	2	4					
15		15	Hydraulic Structure	HENG-3152	Hydraulic Structures I	Open Channel Hydraulics , Soil mechanics II	3	2	3	0	3	5	6	9	2		
				HENG - 3152	Hydraulic Structures II	Hydraulic Structures I	3	2	3	0	2	4					
16		16	Hydropower and Hydro machines	HENG-3161	Hydropower Engineering I	Open Channel Hydraulics	3	2	3	0	2	4	11	16	4		
				HENG - 3162	Hydraulic Machines	Hydraulics II	3	2	1	2	2	4					
				HENG-4163	Hydropower Engineering II	Hydropower Engineering I, Hydraulic Machine	3	2	2	1	3	5					
				HENG-4164	Small Scale Hydropower and Alternate Energy Sources	Hydropower Engineering I	2	1	3	0	1	3					
17		17	Water and Waste Manageme	WSEE - 3171	Water Supply & Treatment	Hydraulics II	3	2	2	2	2	5	5	9	2		
				WSEE -	Wastewater & Solid	Water	2	1	2	2	2	4					

		nt	3172	Waste Management	Supply & Treatment, Hydraulics II												
18	18	Soil and Irrigation	WRIE-4181	Irrigation Engineering	Introduction to Hydrology	2	1	3	0	2	4	4	7	2			
			WRIE - 4182	Soil & Water Conservation Engineering	None	2	1	2	1	1	3						
19	19	Water Resources and Environment	WSEE - 5193	Environmental Impact Assessment	None	2	2	0	0	1	2	10	12	4			
			HENG - 5192	Water Resources Planning & Management	Engineering economics	3	2	3	0	2	4						
			HENG - 5191	River Engineering	Open channel hydraulics	3	2	3	0	2	4						
			HENG - 4193	Flood and Drought Management	Engineering Hydrology	2	1	2	0	1	2						
20	20	Road and Bridge Hydraulics	CENG - 5201	Road Engineering	Surveying II and Soil mechanics I	2	1	3	0	2	4	7	13	3			
			CENG - 5202	Design of steel and Timber structures	Theory of structures	3	2	3	0	3	5						
			HENG - 5203	Bridge and Culvert hydraulics	Road engineering	2	1	3	0	3	4						
21	21	Computer Application in HE	HENG - 5212	GIS and Remote Sensing	Software in Hydraulic Engineering, and surveying II	2	2	0	3	1	4	5	9	2			
			HENG - 4211	Software in Hydraulic Engineering	Comp-1032 , WEE-3175,	3	2	0	3	3	5						

						HE-3161 and HE- 3153											
23		23	Elective courses	HENG- 5231	Groundwater Modeling	Engineering Hydrology & Groundwater Engineering	2	1	0	3	2	4	12	24	6		
				HENG- 5232	Urban Drainage	Engineering Hydrology and water supply and treatment	2	1	0	3	2	4					
				HENG - 5233	Watershed Management	Water Resource Planning & Management, Flood & Drought Management	2	2	1	2	2	4					
				WSEE - 5234	Water Quality Control	Water Supply & Treatment	2	2	0	2	2	4					
				HENG - 5135	River Basin Development	River engineering	2	1	3	0	3	4					
				WSEE- 5236	Environmental Law	Environmen tal Impact Assessment	2	1	3	0	3	4					
24	Practice Project and thesis	24	Internship	HENG - 4241	Holistic Examination	Major Courses	0	0	3	0	2	0	15	30	4	16	
				HENG- 4242	Intern ship Company Evaluation	holistic exam	5	0	0	12	3	10					
				HE NG- 4243	Intern ship Report Evaluation	holistic exam	5	0	0	12	3	10					

			HENG - 4244	Intern ship presentation and Defense	holistic exam	5	0	0	16	0	10				
25		25	Project and Thesis	HENG- 5251	Water Resource Project	Internship	2	0	1	4	1	4	8	18	2
				HENG - 5252	Bachelor Thesis	Should pass all modules	6	0	0	24	0	14			
26		26	Design Tools and Project analysis	Arch- 3261	Architectural drawing	Engineering Geology	2	1	0	0	2	2	4	5	2
				HENG- 3262	Engineering Economics	None	2	1	2	0	2	3			

Courses and Competencies Identified for Exit Exam 2015 First Draft