Blueprint Document for Ethiopian Higher Education Institutions Exit Examination

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

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1. Introduction

To check whether the graduates have acquired the minimum required knowledge, skills and attitudes set on programs curricula or not, the ministry of education has announced the implementation of exit exam for all undergraduate program students, beginning with the 2015 E.C. academic year. To improve the quality of education and ensuring all graduates from higher education institutes satisfy the requirements of the labor market and employability, national wide implementation of competency-based exit exam is crucial. To do so, competency focus areas and core courses were determined.

Based on the prepared competency areas and core courses, it needs to prepare a blueprint to provide a clear and consistent framework for both exam development process and administration. Accordingly matching various competencies with the courses, course contents and learning outcomes, this blueprint is prepared for Hydraulic and Water Resources Engineering program to guide the test developers or content specialists in their process of valid and reliable test construction.

2. Objective/significant of exam blueprint

Exit exam blueprint preparation is generally opted to assist the preparation of an exam that is representative, broadly sampled, and consisting of complete knowledge domain expected of the Hydraulic and Water Resources Engineering students on completion of their study program. The specific objectives of exam blueprint are to:

- Facilitate the construction of a representative and balanced exam items for the selected courses in accordance with the competencies identified.
- Guide exam developers or writers to write or set appropriate exam items.

3. 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.

4. Objectives

4.1. General

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.

4.2. Specific objectives

- To understand the properties and principles of fluid mechanics at a fundamental level with a mathematical approach.
- To familiarize with types of flows, its phenomenon & applications in physical modelling.
- To understand and analyse the surface and groundwater resource.
- To know the basic design principle of hydraulic structures and appurtenant structures.
- To design, construct, operate, and maintain hydropower systems and infrastructures.
- To plan, design and construct water supply systems and water treatment plants.
- To know the basic principles and selection of various irrigation system designs.
- To know the mechanisms of sediment transport and design river training works.
- To plan and manage water resources project.

5. Themes, list of courses and allocated credit hours

Based on the graduate profile and competence of the program, the following fifteen (15) major courses have been selected for exit examination to evaluate knowledge, skill and attitude of the prospect graduates of Hydraulic and Water Resources Engineering. 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 six themes; the details are shown in the following table

Table 1: list of themes and courses

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
		Total ECTS	0

6. Domain based learning outcomes and percentage share of test items

The learning outcomes of each course were distributed into the three domains, (Cognitive, Affective and Psychomotor) according to their nature, see appendix 1. Then after the share of themes and courses were calculated as follows:

- Share of themes = $\frac{Total\,ECTS\,of\,a\,theme}{Total\,ECTS\,of\,the\,program} x\,100$, Where ECTS of a theme is the sum of ECTS of courses in the theme.
- Share of courses per theme $= \frac{ECTS\,of\,the\,course}{ECTS\,of\,the\,theme} \times 100$
- Share of items per course $=$ $Share\,of\,the\,course \times Total\,number\,of\,items$

The detail is shown in appendix 2

7. Conclusion

It’s very important to evaluate the performance of hydraulic and water resources engineering graduate students with a curriculum based exit exam. To do so this blueprint document is compiled to assist the test developers to ensure preparation and handling of exit exam that sets to improve academic programs quality and effectiveness. Accordingly, core competencies and specific learning outcomes of fifteen major courses has been identified for blueprint document preparation among 65-70 courses that the students took in ten semesters (five years) study period. Considering the time allocated for running the assessment and covering the listed learning outcomes 120 items which will assess the knowledge, attitude and skills of graduates were suggested for exit exam preparation.

Appendix

Appendix 1: Exam Blueprint for BSc in Hydraulic and Water Resources Engineering

Themes and Share of the themes in %	**Name and Share of the Courses from the theme in %**	**ECTS**	**General objective/Competency**	**Specific objectives /learning outcomes**	**Learning outcomes**								
					Cognitive						**Affective**	**Psychomotor**	**No. of items**
					Remembering	Understanding	Application	Analysis	Evaluation	Creation/			
Fluid Mechanics (23.08%)	Hydraulics I (33.33%)	5	understand the properties and principles of fluid mechanics at a fundamental level with a mathematical approach	Understand the physical properties of fluids and their relation to molecular properties.		1		1					2
				Identify types, direction of forces and compute forces on hydraulic structures resulting from water pressure			1		1				2
				Determine forces of buoyancy and exertion on submerged body			1		1				2
				Understand pressure distributions in Hydrostatic				1	1				2
				Perform control volume analyses of mass, momentum, and energy conservation			1	1					2
	Hydraulics II (33.33%)	5	familiarize with types of flows, its phenomenon and applications in physical modeling	analyze and design open channel flow				1	1				2
				analyze and design piping systems				1		1			2
				familiar with boundary layer theory		1							1
				understand similarity and similitude of physical models				1				1	2
				characterize the Hydraulic jump on weir, dam, under sluice gate etc.			1	1					2
	Open Channel Hydrauli	5	develop advanced understanding of water flow in open	analyze open channel flow by apply energy and momentum concepts			1	1					2
				describe uniform flow and			1			1			2

	cs (33.33%)		channels	principle of continuity equation by using the Manning and Chezy equations									
				identify gradually and rapidly varied flows and determine their flow profiles		1		1				1	3
				identify steady and unsteady flow types		1		1					2
Hydrology (13.85%)	Engineering Hydrology (55.56%)	5	understand engineering aspect of hydrology for design of water resources projects	Understanding Hydrographs		1							1
				Process hydrological data and analyze flood frequency				1					1
				Flood routing			1	1					2
				Spillway design flood estimation			1	1					2
				Estimate reservoir capacity				1					1
				Manipulate and analyze hydro-meteorological data for design of water resource engineering projects			1	1					2
	Groundwater Hydrology (44.46%)	4	understand groundwater resource, scope and occupancy of groundwater	know the basic concepts of occurrence, laws of movement and distribution of groundwater in relation to natural and artificial influences		1							1
				Understand the directional flow of groundwater, well hydraulics, groundwater exploration, pumping tests of wells, tube wells and tube well development		1	1						2
				aware of the complex nature of groundwater balance and its management				1					1
				know the basic concepts of groundwater models; analyze two-dimensional groundwater								1	1
				understand different types of aquifers and their characteristics, study of groundwater movement,				1					1
				understand Darcy ‘s law, and determine of hydraulic conductivity,			1						1

Hydraulic Structures (12.31%)	Hydraulic Structures I (50.00%)	4	Know the basic design principle of Hydraulic structures	define and categorize dams		1							1
				identify the various reservoir parameters and prepare Area-Elevation-Storage Curve		1							1
				characterize concrete & embankment dams		1							1
				select appropriate site for construction of different types of dams and know the method of foundation preparation				1					1
				understand the basic design principle and analysis of all types of dams				2					2
				understand the various mode of failure in all type of dams and recognize its constructional feature				1					1
				know the technique of diverting river water for the purpose of constructions		1							1
	Hydraulic Structures II (50.00%)	4	Know the basic design principle of appurtenant structures	design dam appurtenant structures like dam outlet works, energy dissipation			1	2					3
				analyse dam safety (Instrumentation and Surveillance)		1	1						2
				design diversion works, cross-drainage and drop structures				2					2
Hydropower Engineering (13.85%)	Hydropower Engineering I (44.44%)	4	The students will be introduced the fundamentals of design, construction, operation, and maintenance of hydropower systems and infrastructure.	understand different sources and historical development of hydropower		1							1
				know waterpower potential, firm and secondary power				1					1
				predict load and demand, determine flow duration curves, storage capacity and poundage				2					2
				know different water conveyance structures such as Intakes, Canals and Tunnels, Forebays, Penstocks and Anchors.				2					2
				analyse problems related to Surge Tanks and Water Hammer				1					1

	Hydropower Engineering II (55.56%)	5	design, plan, supervise and maintenance of hydropower scheme in general; power house and transmission lines in particular.	plan, design and analysis power house				2					2
				plan, design and analysis transmission				1					1
				plan and supervise rehabilitation and maintenance of hydropower		1		1					2
				design full component of mini hydropower plant			1	2					3
				plan and supervise construction of hydropower plant		1		1					2
Water, soil and Environmental management (27.69%)	Water Supply and Treatment (29.41%)	5	plan, design and construct water supply system and water treatment plants	know method of collection and distribution of water		1		1	1				3
				design of water supply schemes			1	2					3
				analyze physical, chemical and biological aspects of water and its treatment methods		1		1				1	3
	Irrigation Engineering (23.53%)	4	design irrigation system and analyze irrigation suitability	differentiate the different types of irrigation systems		1		1					2
				design various types of irrigation schemes			1	2					3
				choose economically visible irrigation scheme		1			1				2
	Water Resources Planning & Management (23.53%)	4	design and optimize water resources systems	know economic aspects of water resources		1							1
				use various optimization techniques in water resources			1	1	1				3
				analyze single and multipurpose water use				1					1
				allocate water resources using linear and dynamic programming techniques				1	1				2
	River Engineering and Sediment Transport (23.53%)	4	know mechanisms of sediment transport, design stable channels and river training works.	know river morphology and its characteristics		1		1					2
				determine quantity and type of sediment that can be transported by a river.		1		1					2
				design river training structures				1	1				2
				know the effect of sedimentation				1	1				2

				on hydraulic structures									
Building and Construction Engineering (10.77%)	Construction Materials (42.86%)	3	Understand the physical and chemical property of construction materials under different conditions	Know engineering properties of construction materials (concrete)		1		1					2
				assess the significance of environmental factors on the behavior and durability of concrete and other construction materials.			1	1					2
				design concrete mix and grouting materials			1	1					2
	Construction Planning and Management (57.14%)	4	Students will know the basic techniques of construction planning and management of water resources project	understand methods of construction control, construction quality and inspection		1							1
				administrate contracts and insurances			1	1					2
				know ways of managing construction, and construction time		1					1		2
				Formulate network techniques like Critical Path Method				1	1				2
Total Number of Items													1

Appendix 2: Share of the Themes/Courses/Items in Percentage

Themes	Course Name	Cr. Hrs.	Weight for the course	Number of Test Items for each course	Learning outcomes								Total Number of Items
					Cognitive Domain								
					Remembering	Understanding	Application	Analysis	Evaluation	Creation/			
Fluid Mechanics theme shares 28 Items	Hydraulics I	5	5/15= 0.33	0.33*28=10	-	1	3	3	3	-	-	-	10
	Hydraulics II	5	5/15=0.33	0.33*28=9	-	1	1	4	1	1	-	1	9
	Open Channel Hydraulics	5	5/15= 0.33	0.33*28=9	-	2	2	3	-	1	-	1	9
	Sub-total	15	3/12=0.25	0.25*34=9	-	1	1	2	1	2	-	1	8
Hydrology theme shares 16 items	Engineering Hydrology	5	5/9= 0.56	0.56*16=9	-	1	2	5	-	-	-	-	9
	Groundwater Engineering	4	4/9=0.44	0.44*16=7	-	2	2	2	-	-	-	1	7
	Sub-total	9											
Hydraulic Structures theme Shares 15 items	Hydraulic Structures I	4	4/8=0.5	0.5*15=8	-	4	4	-	-	-	-	2	8
	Hydraulic Structures II	4	4/8=0.5	0.5*15=7	-	1	2	4	-	-	-	-	7
	Sub-total	8											
Hydropower Eng'g & Hydro-Machines theme shares 17 items	Hydropower Engineering I	4	4/9=0.44	0.44*17=7	-	1	6	-	-	-	-	-	7
	Hydropower Engineering II	5	5/9= 0.56	0.56*17=10	-	2	1	7	-	-	-	-	10

Sub total		9											
Water, soil and Environmental management theme shares 31 items	Water Supply & Treatment	5	5/17= 0.29	0.29*31=9	-	2	1	4	1	-	-	1	9
	Irrigation Engineering	4	4/17= 0.24	0.24*31=7	-	2	1	3	1	-	-	-	7
	Water Resources Planning & Management	4	4/17= 0.24	0.24*31=7	-	1	1	3	2	-	-	-	7
	River Engineering and Sediment Transport	4	4/17= 0.24	0.24*31=8	-	2	-	4	2	-	-	-	8
Sub total		17											
Building and Construction Eng’g theme shares 13 items	Construction Materials	3	4/17= 0.43	0.43*13=6	-	1	2	3	-	-	-	-	6
	Construction Planning and Management	4	4/7= 0.57	0.57*13=7	-	2	1	2	1	-	1	-	7
Sub total		7											
Total for the program		65											120