Ministry of Education

Exam Blueprint for National Exit Examination to be held in 2015 E.C

Band: 1 (Engineering, Science and Technology)

Program: - Bachelor of Science Degree in Water supply and Environmental Engineering

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1. Introduction

The Ministry of Education of Ethiopia has announced the implementation of exit exam for all undergraduate program students (public and private), beginning with the 2022/2023 academic year, in order to improve the quality of graduates produced by higher learning institutions. The exit exam aimed at checking whether students have acquired the required knowledge, skills and attitudes or not. To implement this, it requires determining competency areas for a specific program, which is already completed. Based on the competency areas prepared, it needs to plan the construction of tests.

The BSc curriculum in Water Supply and Environmental Engineering was designed in such a way that the students' knowledge, skill, and attitude are evaluated at the course level. But such an assessment method needs mapping with program learning outcomes to assess the overall competence of the graduates. Therefore, additional techniques which can directly measure students' achievement of program learning outcomes have to be established. In this regard, the most accepted and vital assessment tool that directly measures student achievement of program learning outcomes is program curriculum competencies-based exit exams.

Generally, test blueprint will help to ensure tests: 1) Appropriately assess the achievement of instructional objectives of the course; 2) Appropriately reflect key course goals, objectives and the material learned or covered during the instruction period; and 3) Include the appropriate item formats along with the knowledge and skills being assessed.

Keeping this in mind, the team has prepared this test blueprint document in order to help the test developers or content specialists in their process of valid and reliable test construction. The major points considered in the process of preparing this test blue print were the core competencies that have been already identified for the themes of courses, the course contents, course credit hours, and the learning

outcomes with their corresponding levels of achievement by learning domains. In line with these, the number of test items that should adequately assess the performance of students in all the content topics will be determined through discussion with the content specialists who construct the blueprint and test for their corresponding study program.

Therefore, the aim of this document is to prepare clear test blueprint of the exit exam which helps test constructors to match various competencies with the course content and the appropriate modality of assessment that should be able to measure student performance in all dimensions of knowledge, skill and attitude.

2. Objective of Exit Exam blueprint

Exit exam blueprint preparation is generally opted to assist the preparation of a test that is representative, broadly sampled, and consisting of complete knowledge domain expected of the Ethiopian higher education students on completion of their study program. The specific objectives of test blueprint are to:

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

3. Expected profile of the Graduates

This program is aimed at training manpower required for solving of the country‘s critical water supply, sanitation and Environmental problems which are emerging in the current scenario. Well-qualified Water Supply and Environmental Engineers will be produced through this program who can actively be engaged in the study, planning; design; development and management of Water Supply and Environmental Engineering 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 supply and environmental engineering projects.
- Plan the design of water supply systems, sanitary landfills, sanitation infrastructures, and structures that are related to environmental protection works;
- Create new water and wastewater treatment facilities and model treatment plants as per the acquired knowledge.
- Prepare complete contract documents for water supply and environmental projects like sanitation projects, water supply projects, EIA projects, and projects that are related to environmental protection works like wastewater and solid waste management;
- Plan, design, manage, monitor, and evaluate the operation and maintenance of water supply systems, wastewater treatment projects, environmental engineering projects, and solid waste management projects, as well as the environmental impact assessment for the projects.
- Remodeling and rehabilitation of existing water supply, wastewater treatment, and solid waste management systems.
- Work and communicate effectively with others on multi-disciplinary teams to develop practical, technically sound, cost-effective solutions to complex and diverse environmental engineering problems;

4. General objective the program exit exam

The water supply and Environmental Engineering exit exam would have started with the following objectives:

- To evaluate students whether students are able to plan, design, implement and manage water supply and environmental engineering projects to urban and rural areas;
- To assess the level of understanding and skill of the core competences in the areas of water supply, water quality, water

and wastewater treatment, water technology development and environmental engineering problems solving

5. Specific objectives of exit exam

- To evaluate the students whether they excelled with their specialized department or not
- Ensuring the students to be competent with other university/country students with the same field of specialization.
- To make sure that the students would have exactly meets the need of skill, competence and creative mind for the companies.
- Improving public trust and confidence in WSEE professionals
- Creating competitive spirit among the same faculties/departments in Ethiopia with the competes to encouraging them to give due attention to the national standards
- To make available skilled and competent manpower for national and international market and industries.

6. Themes, list of courses, credit hours and share percentages

There are six themes identified and validated during core competences preparation period. For the undergraduate program of water supply and Environmental Engineering total of fifteen courses with 38 credit hours have been validated as eligible for the exit exam preparation. List of all courses with their respective credit our as per the program curriculum has been presented in the following Table 1;

Table1: Themes, list of courses, credit hours and share percentages

Themes	List of Courses	Cr. Hr.
Theme 1: Water Supply	Water supply Engineering	3
	Water treatment	3

	Community water supply and Sanitation	2
Share of Theme 1 = 8/38*100 = **21%**		
Theme 2: Wastewater Engineering	Sewer system	3
	Wastewater treatment	4
Share of Theme 2 = 7/38*100 = **18%**		
Theme 3: Industrial waste and Environmental protection	Solid and hazardous waste management	2
	Air, noise and soil pollution and management	3
Share of Theme 3 = 5/38*100 = **13%**		
Theme 4: Water Resources and Environment	Introduction to Environmental Engineering	2
	Environmental Impact Assessment	2
	Groundwater Hydrology	3
	Water and Environmental law	2
Share of Theme 4 = 9/38*100 = **24%**		
Theme 5: Water Quality and Sanitation	Water supply and sanitation Installation	3
	Water Quality Management and Modeling	2
	Sanitation	2
Share of Theme 5= 7/38*100 = **19%**		
Theme 6: Construction Material	Construction materials	2
Share of Theme 6 = 2/38*100 = **5%**		
Total credit hours		0

7. Learning outcomes in terms of the three domains (Cognitive, Affective and Psychomotor)

The Water Supply and Environmental Engineering program is primarily designed to train viable, job-oriented, marketable and problem solving professionals in the planning, design, construction and operation of water supply and sanitation facilities as well as other related infrastructure of environmental protection of natural resources, such as air, water and soil. Hence, the professional profile of Water Supply and Environmental Engineering program is to Optimum utilization of available water resources for commercial, industrial and domestic water supply systems, irrigation systems etc.

7.1. Knowledge

The graduate is expected to know the basic concept of:

- Planning, design and implementation of a rural and urban water supply system
- Water and waste water treatment system at all levels within the community or at the time of emergency water supply and sanitation system
- Analyze the water and waste water quality based on Ethiopian and international standards.
- Design and monitor sanitary and sewerage systems, municipal or hazardous water disposal sites
- Monitor air pollution, understand control equipment, and predict the movement of contaminants in air, water, and soil.
- Conduct environmental impact assessments, take remedial actions to address environmental impacts, and develop environmental regulations and standards.

7.2. Skill

The graduates of water supply and environmental Engineering is able to participate and professionally perform engineering services in different project would have the following skills:

- Identification of problems with existing infrastructure and elaboration of technically and economically feasible concepts for their solution
- Should be able to supervise construction, control and approve contract documents, and settle claims and disputes within the community and governmental bodies
- Controlling and managing water supply and sanitation construction periods
- Select proper sites, ensuring the quality of facilities to be rehabilitated or constructed, and follow up to ensure proper utilization of available resources.

7.3. Attitude

The water supply and Environmental Engineer should have the following attitudes:

- Recognize the importance of potable water supply and environmental protection for the economic growth of the country.
- Desire to plan the protection and achievement of water resources in the given community to have a protected environment in the country.
- Interested in viewing a community with good water quality, adequate water supply, and a clean environment.

8. Exit Exam blueprint Table specification

The exit exam blueprint table of specification is the roadmap of the exam which entirely consists the identified core competences which measures the learning outcomes of graduates from water supply and environmental engineering program. The detail specification of exit exam blueprint has been presented in Table 2 below:

Ministry of Education
Higher Education Sub-sector
Table2: Table specification of Exit Exam Blueprint for BSC in Water supply and Environmental Engineering Program

Themes and Share of the themes in %	Name and Share of the Courses in %	Credit hour	General objective/Competency	Specific objectives	Learning outcomes								No. of items
					Cognitive						Affective	Psychomotor	
					Remembering	Understanding	Application	Analysis	Evaluation	Creation/ Synthesis			
Theme One: Water Supply (21%)	Water supply Engineering	3	Students will understand the design of water supply system	LO1	1	-	-	2	-	-	-	-	3
				LO2	-	1	-	1	-	1	-	-	3
				LO3	1	-	1	-	-	-	1	1	4
	Water treatment	3	Students will understand the various methods of water treatment systems.	LO4	1	-	2	-	-	2	-	-	5
				LO5	1	2	-	1	-	1	-	-	5
	Community water supply and Sanitation	2	Students will have a broad knowledge of community water supply and sanitation system	LO6	-	-	1	-	-	1	-	-	2
				LO7	-	1	-	-	-	1	-	-	2
				LO8	-	1	-	-	-	-	1	-	2
Theme Two: Wastewater Engineering (18%)	Sewer system	3	Students will be able to plan, design and construction of sewerage system.	LO9	1	1	-	-	-	-	1	-	3
				LO10	-	1	1	-	1	-	-	-	3
				LO11	1	-	-	1	-	2	-	-	4
	Wastewater treatment	4	Students will understand various types of wastewater treatment systems	LO12	2	1	-	-	-	1	-	-	4
				LO13	1	2	-	-	1	2	-	-	6
				LO14	1	2	-	-	-	-	-	-	3
Theme Three: Industrial waste and Environmental protection (13%)	Solid and hazardous waste management	2	Students will able to understand the basics of Solid and hazardous waste management system	LO15	1	1	-	-	1	-	-	-	3
				LO16	1	-	-	1	-	1	-	-	3
	Air, noise and soil pollution and management	3	Students will understand various mechanism of Air, noise and soil pollution control	LO17	1	1	1	-	-	-	-	-	3
				LO1	1	1	-	-	-	-	1	-	3

			and its management	8									
				LO19	1	1	-	-	-	-	-	-	2
				LO20	-	-	-	1	1	-	-	-	2
Theme Four: Water Resources and Environment (24%)	Introduction to Environmental Engineering	**2**	Students will understand essential science and engineering principles needed for environmental engineering	LO21	1	-	-	1	-	-	-	-	2
				LO22	1	-	-	-	-	-	-	-	1
				LO23	-	1	-	-	1	-	-	-	2
				LO24	-	1	-	-	-	-	-	-	1
	Environmental Impact Assessment	**2**	Students will understand philosophy and methodology to assess environmental impacts of development projects	LO25	1	1	-	-	-	-	1	-	3
				LO26	-	-	-	2	1	-	-	-	3
	Groundwater Hydrology	**3**	Students will understand basic concept of Groundwater Hydrology	LO27	1	1	-	-	-	-	-	-	2
				LO28	1		1	1	-	-	-	-	3
				LO29	-	2	1	-	-	-	-	-	3
				LO30	-	1	1	-	-	-	-	-	2
	Water and Environmental law	**2**	Students will understand the basic knowledge of relevant Ethiopian, regional and international legal considerations for water law, efficient environmental protection.	LO31	1	2	-	-	-	-	-	-	3
				LO32	1	-	2	-	-	-	-	-	3
Theme Five: Water Quality and Sanitation (19%)	Water supply and sanitation Installation	3	Students will be able to design water supply and sanitation system installation for buildings	LO33	1	-	1	-	1	-	-	-	3
				LO34	1	-	-	-	-	2	-	-	3
				LO35	1	1	-	-	-	-	-	1	3
	Water Quality Management and Modelling	2	Students will understand the basic knowledge of water quality management and modelling	LO36	-	-	1	-	1	-	-	-	2
				LO37	-	-	-	-	-	1	-	-	1
				LO38	1	1	-	1	-	-	-	-	3

	Sanitation	2	Students will understand the basic knowledge of Sanitation system	LO39	1	1	-	-	-	-	-	-	2
				LO40	-	1	-	-	-	1	-	-	2
				LO41	1	1	-	-	-	-	-	-	2
Theme Six: Construction Material **(5%)**	Construction materials	**2**	Students will identify and utilization of different construction materials.	LO42	1	-	1		-	-	-	-	2
				LO43	1	1		-	-	-	-	-	2
				LO44	-	-	-	1	-	1	-	-	2
Total													120

Key: In the cells/boxes there are numbers that indicate the number of items that correspond to the levels of domains.

Formulas used:

- **Percent share for Theme i =** $\frac{Total\,Credit\,hour\,of\,the\,Theme\,i}{Total\,Credit\,hour\,of\,the\,Program\,i}$x100
- **Percent share for Course i =** $\frac{Credit\,hour\,for\,Course\,i}{Total\,Credit\,hour\,of\,the\,Theme\,i}$x Percent share for Theme i
- **Total test items for Theme i =** $\frac{Total\,Credit\,hour\,for\,Theme\,i}{Total\,Credit\,hour\,for\,Program\,i}\,X\,Total\,of\,items$ for the program
- **Total of items for course =** $\frac{Credit\,hour\,for\,Course\,i}{Total\,Credit\,hour\,for\,Theme\,i}\,X\,Total\,number\,of\,items\,for\,Theme\,i$

Table 3: Code of learning outcomes

Learning outcomes	
LO1	Students will develop a broader understanding of population forecasting methods
LO2	Students will be able to compute water demand analysis,
LO3	Students will be able to select reliable water sources, collection and distribution system.
LO4	Students will be able to design various methods of water treatment systems.
LO5	Students will be able to analyse water quality and understand different chemicals used in water treatment system.
LO6	Students will be able to apply Community Organization techniques.

LO7	Students will be able to design Community water supply schemes.
LO8	Students will understand Sanitation system with community level
LO9	Students will identify different urban pollution sources
LO10	Students will be able to quantify sewage
LO11	Students will be able to design sewer systems.
LO12	Students will be able to identify the various wastewater sources and its treatment systems
LO13	Students will be able to design various methods (conventional, stabilization ponds, constructed wetlands systems etc.) of wastewater treatment system.
LO14	Students will understand self-purification mechanisms
LO15	Students will differentiate sources of solid and hazardous waste.
LO16	Students will be able to identify and design different methods of solid waste management systems (collection, handling, transfer/transport, reuse, and disposal systems)
LO17	Students will be able to identify different types of air pollutants, their effects.
LO18	Students will identify different sources of noise pollution and their effects.
LO19	Students will understand Soil pollution, its composition, prevention, and conditioning methods.
LO20	Students will understand different management systems of Air, noise and soil pollution
LO21	Students will understand ecology and its Relation to the Environment
LO22	Students will be able to describe Physics of the Environment
LO23	Students should know Mathematics of Growth
LO24	Students will understand Air and water pollution
LO25	Students will be able to know the basic concepts of environmental impact assessment
LO26	Students will be able to analyse environmental impact and its mitigation measure for adverse environmental impacts in any development projects
LO27	Students will be able to know the basic concepts of Groundwater Hydrology
LO28	Students will be able to analyse pumping test data and interpretation of the result.
LO29	Students will be able to know complex nature of groundwater balance and its management.
LO30	Students will be able to understand artificial recharge and its application
LO31	Students will understand the legal framework of water rights and environmental protection
LO32	Students will be able to apply valid legal regulations for pollution control measures.
LO33	students will be able to select suitable water supply and sanitary installation materials.
LO34	Students will be able to design building water supply and sanitary installation
LO35	students will understand the building services of water supply and sanitation and their integration with

	architectural design
LO36	Students will be able to characterize water quality parameters
LO37	Students will be able to model and simulate water quality.
LO38	Students will understand water quality management techniques
LO39	Students will understand options available for sanitation system
LO40	Students will design on-site and off-site sanitation systems
LO41	Students will know resource recovery system for urine and fecal material
LO42	Students will be able to describe physical and chemical property of construction materials
LO43	Students will be able to describe engineering properties of concrete
LO44	Students will be able to design concrete mix, produce concrete and grouting materials

9. Conclusion

Exit examination can have a vital role in producing knowledgeable, skillful and attitudinally matured graduates. It contributes to prepare competent graduates as it can serve as a quality check for effectiveness. It also helps in improving academic programs quality and effectiveness. Furthermore, it can create the platform for cooperation among academic programs at different universities to work jointly to improve the programs quality.

In view of this, this document is produced to assist the setting of the exit examinations for water supply and environmental engineering programs, which is being delivered by Ministry of Education. To meet the graduation profile, competency and learning outcome, exit exam competency selection and identifying core course was done for 2015 EC graduating students. As a result, preparing test blueprint is necessary to prepare fairly distributed items based on the above criteria.

Appendix

Table : Example for the calculation of share of themes, courses and items from a course from a total of 120 test items for one program

Themes	Course Name	Learning outcomes	Credit hour	Weight of course or proportion	Number of test items from each course	**Cognitive**						**Affective**	**Psychomot**	Total
						Remembe	Understa	Apply	Analyze	Evaluate	Create			
Theme One Share = 34 items from the total	1		3	3/12 = 0.25	0.25*34 = 9	-	2	2	1	2	1	-	1	9
	2		4	4/12 = 0.333	0.333*34 = 11	1	2	2	1	2	1	1	1	11
	3		2	2/12 = 0.167	0.167*34 = 6	-	1	-	2	2	1	-	-	6
	4		3	3/12 = 0.25	0.25*34 = 8	-	1	1	2	1	2	-	1	8
	Theme one total credit		**12**											
Theme Two Share = 49 items from the total	1		3	3/17 = 0.18	0.18*49 = 9	-	1	2	2	2	1	1	-	9
	2		3	3/17 = 0.18	0.18*49 = 9	-	1	2	1	2	1	-	2	9
	3		4	4/17 = 0.24	0.24*49 = 11	-	2	2	3	2	1	-	1	11
	4		4	4/17 = 0.24	0.24*49 = 11	1	2	1	2	1	2	1	1	11
	5		3	3/17 = 0.18	0.18*49 = 9	-	2	2	1	2	1	-	1	9
	Theme two total credit		**17**											
Theme Three Share = 37 items from the total	1		3	3/13 = 0.23	0.23*37 = 9	-	1	2	1	2	1	-	2	9
	2		3	3/13 = 0.23	0.23*37 = 9	-	1	2	2	2	1	-	1	9
	3		4	4/13 = 0.31	0.31*37 = 10	1	2	1	2	1	2	1	-	10
	4		3	3/13 = 0.23	0.31*37 = 9	-	1	2	1	3	1	-	1	9
	Theme three total credit		**13**											
Total for the program			42			3	19	21	21	24	16	4	12	120

Note: The number of items assigned in the levels of domains is based on the nature of learning outcomes/objectives.