Ministry of Education

Test Blueprint for National Exit Examination

(Revised Version – March, 2024)

Band: Engineering and Technology

Program: - Bachelor of Science Degree in Water Resources and Irrigation Engineering

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1. INTRODUCTION

A study of Water Resources and Irrigation Engineering is a field of study that deals with collecting and distributing water where and when it's needed. The field gives greater emphasis to irrigation engineering and drainage systems, river training and flood protection works, construction of dams and reservoirs for water supply and irrigation purposes as a whole. Undergraduate studies offer a series of basic engineering and applied courses in the area of water resources, irrigation and water supply engineering (fluid mechanics, hydraulics, hydrology, groundwater, water supply and wastewater systems, irrigations and drainage, hydraulic structures, river hydraulics, sedimentation, river-training works, flood protection etc.). The program also offers civil-engineering courses, which includes elements of geo-mechanical engineering, structural engineering, construction engineering, materials engineering, transportation engineering, geodesic surveying and geology.

Ensuring quality and relevant education in Higher Education institutions is one of the challenges that remained to be solved. In a pursuit to rise educational outcomes in terms of quality and relevance, many countries currently aim to improve accountability in the school system. Many school systems provide educational outcome information. However, the Exit exam provides outcome information to be comparable across schools on an external standard.

Moreover, several concerns regarding the scheme of exit exam including efforts and costs to maintain the process, opposing arguments, exposing potential weakness in the education system, fear of impeding flexibility within curriculum, quality and reliability of the employee, ownership, exam administration, and management and cheating will be considered. To address this exit exam, test blueprint of the examination must be well prepared and it must be easily guide to exam question preparation.

A Test Blueprint or the blueprint used for examination contains the strategy of exam by an educational institution. A Test Blueprint can also be defined as the matrix or list which shows the questions count and the variety of the test questions covered in the selected subject content and also perpendicular to the learning objectives and how much weight does each of the question carries according to a specific topic. A test blueprint is a map of the objectives that are assessed on the test as well as a map of the different levels of learning that each question addresses.

2. OBJECTIVES OF TEST BLUEPRINT

Test 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. STEPS TO DEVELOP TEST BLUEPRINT

i. Listing the identified core competencies corresponding to the respective course
ii. Listing the specific and minimum competencies to be assessed by the exam
iii. Listing out the major learned course contents corresponding to these listed minimum competencies.
iv. Listing the specific, measurable learning outcomes under these minimum competencies using action verbs (Note: the number and the importance of these learning outcomes proportionally contribute to the total test items. The weight of the categories of the list of learning outcomes under each competencies and contents should lead to the number of total test items to be constructed)
v. Determination of the test format
vi. Content weighting - Experts judge the weight to be given to the listed learning outcomes and their corresponding contents.
vii. Identifying the categories of learning domains to which each of these learning outcomes belongs using their action verbs.
viii. Construction of test blueprint table
ix. Allocating the number of test items for each learning outcomes by their corresponding types and levels of learning domains.
x. Determination of the sub-total and total test items by their categories of learning domains and learning outcomes.

4. EXPECTED PROFILE OF THE GRADUATES

This program is aimed at training man power required for the realization of the use of country's vast water resources potential. Well-qualified Water Resources and Irrigation Engineers will be produced through the program who can actively be engaged in the planning, design, construction 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 projects; and design irrigation, drainage structures and other related to environmental protection works; Prepare complete contract documents for water resources projects like, Irrigation projects, drainage facilities, water supply projects, and projects which are related with environmental protection works; Plan, design, manage and supervise the construction of Irrigation, drainage structures and related civil engineering works; Plan, design, manage, monitor and evaluate the operation and maintenance of irrigation and drainage systems; Remodeling and rehabilitation of existing water supply, hydraulic and hydropower systems.

Therefore, Water Resources and Irrigation Engineering graduates can work in the area of hydrology, river engineering, design and construction of dams, weirs, barrages, canals, ditches, groundwater development for any purpose, research institutions and various other hydraulic and irrigation structures and civil works at any governmental and non-governmental organizations from the World to Woreda level.

5. COMPETENCIES AND LEARNING OUTCOMES

5.1. Competencies

Knowledge: Specifically, the trainees will be equipped with the knowledge that enables them to execute the following tasks:

- Identify water resources and irrigation problems of existing infrastructure and elaborate technically and economically feasible concepts for their solution.
- Understand the applicability of hydrology for water resource development.
- Understand the different hydraulic and irrigation structures, included from irrigated field to source of water.
- Plan water resource projects and optimization techniques.
- To know the sources of water including surface water and groundwater.
- Define the different irrigation methods, such as surface irrigation, sprinkler irrigation, and drip irrigation, including their design principles and efficiency consideration.
- State the hydraulics of flow, such as open channel flow and pipe flow, conveyance and distribution.
- Understanding of sediment transport mechanisms, River development and training works.
- Analyze turbulent and laminar flow distribution.
- Analyze demand and supply for irrigation and domestic purpose.

Skills: The graduates of Water Resources and Irrigation Engineering are able to participate and professionally perform engineering services in different project would have the following skills:

- On-site surveys, pre feasible and detail designs specifications of irrigation and water resources projects
- Design any hydraulic, irrigation, drainage structures and any related civil engineering works.
- Construct any hydraulic, irrigation, drainage structures and any related civil engineering works.
- Ability to analyze and interpret hydrological data, including rainfall runoff, streamflow and water balance calculations.
- Problem-solving skills for addressing water-related challenges.
- Apply basic software skills related to Water Resources and Irrigation Engineering.

Attitude: The Water Resources and Irrigation Engineer should have the following attitudes:

- Recognize the importance of irrigation projects during the planning, construction and operation of the project.
- Recognize the status of irrigation practices in the country in terms of irrigation scheduling.
- Express the importance of hydraulic structures.

5.2. Learning Outcomes

- Determine design flood using different methods and identify best fitting methods.
- List and describe the properties of aquifers that control the movement and storage of groundwater.
- Use Darcy's Law to explain the roles of aquifer properties and driving forces in governing the rate of groundwater flow.
- Analyze turbulent and laminar flow distribution.
- Apply the Manning Equation and Chezy Equation to describe uniform flow and principle of continuity equation.
- Identify flow as gradually varied flow and rapidly varied flow and determine their flow profiles in different types of channels hydraulic structures.
- Characteristics of rapid varied flow over spillways and hydraulic jump analysis and flow under gates.
- Understand definition, scope and ill effect of irrigation in Ethiopia
- Analyze soil moisture content and basic concept of soil water dynamic.
- Estimate field and scheme water supply as net irrigation requirement for surface irrigation
- Determine crop water demand, net and gross depth of irrigation.
- Analyze different methods of surface irrigation methods and their design, layout, evaluation and operation at the field.
- Understand the concept of pressurized irrigation and design sprinkler and drip irrigation system with regard to prevailing physical resources.
- Know different irrigation network structures and identify different design cross drainage structures.

- Understand and design different components of headwork structures.
- Design and analysis different types of canal regulating structures.
- Design surface and subsurface drainage systems for irrigated agriculture and water-logged areas.
- Know basic elements of dams, components of dams and the importance of dam construction.
- Understand most suitable site that could be selected for design and construction of a dam.
- Be familiar with the ancillary components of dams or appurtenant structures, which are provided for dam safety and environmental considerations.
- Understand the need of energy dissipation and outlet works for dams.
- Design different type of spillways and energy dissipators.
- Know the detail design of stable channel and River development and training works.
- Use optimization techniques for water resources management and planning.
- Forecast water demand and the population in designing water supply schemes.
- Evaluate the best source of water with regard to quality, capacity and cost.

6. THEMES AND LIST OF COURSES

Based on the graduate profile and competence of the program, six modules/categories have been selected. Under those themes, fourteen (14) major courses have been selected for exit examination to evaluate knowledge, skill and attitude of the prospect graduates of Water Resources and Irrigation Engineering. The detail of each course with credit hour coverage are shown in Table 1

Table 1: List of themes, selected courses and their credit hours.

Theme number	Course's Theme	Selected Courses for the Exit Exam	Credit hour in ECTS
1	Hydrology	Engineering Hydrology	5
		Groundwater Engineering	5
2	Fundamental of Hydraulics	Hydraulics	5
		Open Channel Hydraulics	5
3	Irrigation and Drainage Engineering	Surface Irrigation	5
		Pressurized Irrigation	5
		Irrigation Structures I	5
		Irrigation Structures II	5
		Drainage Engineering	5
4	Hydraulic Structures	Dam Engineering-I	5
		Dam Engineering-II	5
		River Engineering and Sediment Transport	4
5	Water Resources study, Planning and Management	Water Resources Planning and Management	4
6	Water Supply Engineering	Water Supply and Sanitation Engineering	5
Total Credit Hours in ECTS			68

Table 2: Test Blueprint (Table Specification) for BSc. in Water Resources and Irrigation Engineering.

Themes and shared of the themes in %	Name of the course	Credit Hours (ECTS)	General objectives	Learning Outcomes	Learning outcomes								No. of items
					Cognitive						Affective	Psychomotor	
					Remembe	Understan	Applicatio	Analysis	Evaluation	Creation/Synthesis			
Hydrology (14.706)	Engineering Hydrology	5	To develop hydrographs, frequency analysis of rainfall and stream flow data, determine design discharge for water related structures, flood routing, reservoir capacity and determine drainage design discharge for urban areas.	Describe flood routing	-	2	-	-	-	-	-	-	8
				Classify the different methods of design flood determination and their limitations	-	2	-	-	-	-	-	-	
				Calculate the design discharge using rational method	-	-	-	2	-	-	-	-	
				Define hydrograph with its components	1	-	-	-	-	-	-	-	
				Discuss about frequency analysis	-	1	-	-	-	-	-	-	
	Groundwater Engineering	5	Understand about basic theories, principles and mathematical model governing subsurface flow and deals with subsurface storage mechanism and flow pattern.	Describe the concept of ground water occurrence	-	2	-	-	-	-	-	-	7
				Independently recommend the types of the aquifers for water well development.	1		-	-	-	-	-	2	
				Apply Darcy's Law on the groundwater flow and indicate its applicability.	-	1	-	-	-	-	-	1	
Fundamental of Hydraulics (14.706)	Hydraulics	5	To familiarize them with open channel flows, flows in pipe networks, different flow phenomenon in pipe and open channel	State the application of dimensional Analysis.	-	2	-	-	-	-	-	-	7
				Discuss the characteristics of a boundary layer.	-	2	-	-	-	-	-	-	
				Compare laminar and turbulent flow.	-	1	-	2	-	-	-	-	
		5		Classify open channel flow under different criteria	-	2	-	-	-	-	-	-	8

	Open Channel Hydraulics		To know the basic principles of Hydraulics, Open Channel flow and its classification, to develop a mechanistic understanding of steady and unsteady fluid flow in channels including streams and rivers	Understand the difference between open channel flow and pipe flow.	-	1	-	-	-	-	-	-	
				Identify flow as gradually varied flow and rapidly varied flow and analyze their flow profiles in different types of channels hydraulic structures	-	1	-	2	-	-	-	-	
				Describe Specific Energy; Critical Depth; Uniform and critical flow and its computation.	-	2	-	-	-	-	-	-	
Irrigation and Drainage Engineering (36.765)	Surface Irrigation	5	To understand the basics of surface irrigation and to offer the knowledge of soil-water-plant relationships, crop water requirements and different surface irrigation methods.	Discuss the importance, scope and ill effect of irrigation	-	-	-	-	-	-	2	-	7
				Discuss the different methods of surface irrigation with their selection criteria.	-	2	-	-	-	-	-	-	
				Analyze soil moisture content	-	-	-	1	-	-	-	-	
				Define crop water requirement, net and gross irrigation requirement and distinguish their determination approaches	1	-	-	1	-	-	-	-	
	Pressurized Irrigation	5	To analyze pressurized irrigation system and competent to understand the hydraulic, adaptability and working principles of pressurized irrigation systems.	Know the difference between pressurized irrigation and surface irrigation	-	1	-	-	-	-	-	-	7
				Know sprinkler systems, Types and characteristics, adaptability, selection, system components, uniformity and efficiency, losses, water distribution patterns.	1	2	-	-	-	-	-	-	
				State drip irrigation system; Components of Trickle System; Water distribution in the soil related to trickle system.	1	2	-	-	-	-	-	-	
	Irrigation Structure-I	5	Understand different irrigation network structures, conveyance and cross drainage	Know different irrigation network structures.	1	-	-	-	-	-	-	-	8
				Accurately know the design approaches of irrigation and drainage canals.	1	-	-	-	-	-	-	2	

			structures, Measuring and regulating structures.	Identify different cross drainage structures.	-	2	-	-	-	-	-	-	
				Know the different regulating structures.	-	2	-	-	-	-	-	-	
	Irrigation Structure-II	5	To understand diversion head works, design and analyze headwork structures and canal regulating structures	Proficiently recommend the suitable diversion head work for irrigation projects.	-	-	-	-	-	-	-	2	8
				Follow the design approach for diversion weir and design its waterway, discharge intensity, scour depth, regime velocity of flow.	-	-	-	2	-	-	1	-	
				Understand the different canal regulating structures.	-	2	-	-	-	-	-	-	
				Know the types of drop structures.	-	1	-	-	-	-	-	-	
	Drainage Engineering	5	To know the different components of surface and sub-surface drainage systems, design surface and subsurface drainage systems for irrigated agriculture and water-logged areas	Know the different components of surface and sub-surface drainage systems, cause of waterlogging and ponding	-	2	-	-	-	-	-	-	7
				Know the design criteria for surface and subsurface drainage systems.	-	1	1	-	-	-	-	-	
				List and discuss the different types of subsurface drainage system	1	1	-	-	-	-	-	-	
				Explain land reclamation techniques for salt affected soils.	-	1	-	-	-	-	-	-	
Hydraulic Structures (20.588)	Dam Engineering -I	5	Understanding of the basic principles used in design and analysis of embankment and concrete dams.	Know the basic elements of dams, components of dams and the importance of dam construction.	-	1	-	-	-	-	-	-	7
				Explain the different types of dams.	-	2	-	-	-	-	-	-	
				Follow the design principles and procedures of dam construction.	-	-	-	-	-	-	-	3	
				Express factors governing selection of dam type.	-	1	-	-	-	-	-	-	
	Dam Engineering -II	5	Understand the basic principles and design of dam appurtenant structures.	Discuss the components of dams or appurtenant structures, which are provided for dam safety and environmental considerations.	-	1	-	-	-	-	-	-	7
				Express the importance of intakes, gates and spillways.	-	-	-	-	-	-	2	-	

				Recognize and explain the need of energy dissipation and outlet works for dams.	1	1	-	-	-	-	-	-	
				Understand basic concepts of dam safety, instrumentation and surveillance.	-	2	-	-	-	-	-	-	
	River Engineering and Sediment Transport	4	To examines the processes of sediment entrainment, transport, and deposition and the interaction of flow and transport in shaping river channels.	Understand sediment transport in open channels.	-	2	-	-	-	-	-	-	6
				Discuss river characteristics	-	2	-	-	-	-	-	-	
				Discuss river morphology and regime	-	2	-	-	-	-	-	-	
Water Resources study, Planning and Management (5.882)	Water Resources Planning and Management	4	To know how to plan, develop and manage water resources and to develop suitable plans for water resource development and management.	Describe the stages in Planning a Water Resources Project	-	2	-	-	-	-	-	-	6
				Describe the concepts of water resources system and system analysis	-	2	-	-	-	-	-	-	
				Know the major challenges in water resources development and Causes of water resources problems	-	1	-	-	-	-	-	-	
				List the major steps in Water Resources Management and Common goals of planning and management.	1	-	-	-	-	-	-	-	
Water Supply Engineering (7.353)	Water Supply and Sanitation Engineering	5	Understanding of techniques used to forecast demand and population for designing water supply scheme	Discuss and choose forecast techniques of water demand and the population in designing water supply schemes	-	2	1	-	-	-	-	-	7
				Interpret the best source of water with regard to quality, capacity and cost.	-	2	1	-	-	-	-	-	
				Describe water distribution system and its layout	-	1	-	-	-	-	-	-	
Total		68											100

7. SHARE OF THE THEME AND COURSE

Share of the themes in program and share of the courses in the themes should be taken as follows:

Share of themes (T) = $\frac{a}{b}\ x100$, Where "a" is the credit hour of a theme and "b" is the total credit hour of the program. Credit hour of a theme is the sum of credit hours of courses in the theme.

$$\text{Share of courses per theme (C)} = \frac{\text{Credit hour of the course}}{\text{Credit hour of the theme}} \text{ x100}$$

Using the above two equations, the share of theme per program and share of courses per theme are summarized in Table 3.

Table 3: Calculation of share of themes, courses and items from a total of 100 test items for Water Resources and Irrigation Engineering program

Themes and its Share (%)	**Selected Courses for the Exit Exam**	**Credit hour in ECTS**	**Weight of course or proportion**	**Number of test items from each course**	**Learning outcomes**								**Total**
					Cognitive						**Affective**	**Psychomotor**	
					Remembering	**Understanding**	**Applicatio**	**Analysis**	**Evaluation**	**Creation/Synthesis**			
Hydrology (14.706)	Engineering Hydrology	5	0.5	7.353	1	5		2					8
	Groundwater engineering	5	0.5	7.353	1	3						3	7
	Total	**10**											
Fundamental of Hydraulics (14.706)	Hydraulics	5	0.5	7.353		5		2					7
	Open Channel Hydraulics	5	0.5	7.353		6		2					8
	Total	**10**											
Irrigation and Drainage Engineering (36.765)	Surface Irrigation	5	0.2	7.353	1	2		2			2		7
	Pressurized Irrigation	5	0.2	7.353	2	5							7
	Irrigation Structure-I	5	0.2	7.353	2	2						4	8

	Irrigation Structure-II	5	0.2	7.353		3		2			1	2	8
	Drainage Engineering	5	0.2	7.353	1	5	1						7
	Total	**25**											
Hydraulic Structures (20.588)	Dam Engineering-I	5	0.357	7.353		4						3	7
	Dam Engineering-II	5	0.357	7.353	1	4					2		7
	River Engineering and Sediment Transport	4	0.286	5.882		6							6
	Total	**14**											
Water Resources study, Planning and Management (5.882)	Water Resources Planning and Management	**4**	1	5.882	1	5							6
Water Supply Engineering (7.353)	Water Supply and Sanitation Engineering	**5**	1	7.353		5	2						7
Total		68			10	62	3	10	0	0	5	10	100

8. 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.

Preparing test blueprint is necessary to fairly distributed items based on the course content, overall items of the questions and on the nature of the course. It was found that for this specific BSc program, test item of 100 was selected as benchmark. Based on this, for each learning outcomes distributed, shared percent for the theme and the course were calculated.