Ministry of Education

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

Band: ONE

Program: - Bachelor of Science Degree in Meteorology and Hydrology

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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.

Planning of a test is a first and vital step in the construction of an achievement test. An achievement test demands very systematic and careful planning, as a fact that good planning is a symbol of success. Tests are the tools that provide scores that measure level of student learning and study program learning outcomes. In order to achieve the valid and reliable measurement of student learning and program learning outcomes, the development of valid and reliable test is the mandatory. Test should be able to measure student performance in all dimensions of knowledge, skill and attitude. The carefully planned test construction contributes to improve the overall quality of the test in terms of test content validity, difficulty level, discrimination power and test reliability. Test preparation is not an easy task; it requires a careful planning and guideline to make the task simple. Test construction needs the preparation of test blue print. Test blueprint is defined as a complete plan that explains how to develop a test. The

term refers to a map or specification of assessment to ensure that all aspects of the curriculum and educational domains are covered by the assessment programs over a specified period of time. It helps curriculum developers/test constructors to match various competencies with the course content and the appropriate modality of assessment.

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 guideline 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 main purpose of this manual is to give direction on how to develop blueprint for content specialists so that they can develop a test blueprint for their respective program.

2. Objective 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. Expected profiles of graduates

This program is aimed at producing graduates that can have adequate knowledge, skills and attitude towards application of Meteorology and Hydrology. Specifically:

- Ability to couple or integrate hydrological and climate models for various water resource applications; flood and drought frequency analysis, monitoring and warning; climate change impact assessment, etc.
- Ability to carry out operational services such as climate monitoring, weather analysis and forecasting, flood forecasting, early warning etc.
- Ability to investigate the interactions and feedbacks between surface (boundary layer) hydrological processes and atmospheric processes
- Conduct Meteorology and Hydrology related laboratory and field observation;
- Able to evaluate water quality, water use and surface and ground water interaction and to investigate the interactions and feedbacks

between surface (boundary layer) hydrological processes and atmospheric processes.

- Ability to render advisory services on the provisions of weather & climate, water resource management, water balance information of a region to various socioeconomic sectors;
- Able to make observation, analyze and control the quality of meteorological and hydrological research data; and analyze large meteorological and hydrological data using computer programs;
- Able to assess and map groundwater availability, quality and sustainability and to prepare flood inundation zone map;
- Able to apply mathematics and statistics in Meteorological and Hydrological applications;
- Assess whether risk to aid environmental, agricultural, energy and water resource management;
- Render public consultations in areas closely related to Meteorology and Hydrology;

4. Objectives of the Exit Examination

The Meteorology and Hydrology 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 Meteorology and Hydrology
- Ensuring whether the graduation profile of Meteorology and Hydrology curriculum have achieved at least common standards of knowledge and practical skills
- Improving public trust and confidence in Meteorology and Hydrology activities of 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 Meteorology and Hydrology departments in Ethiopia with the vies to encouraging them to give due attention to the national standards

5. Themes, List of Courses and Allocated Credit Hour

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

Category	Themes	Course Name	Cr.
Meteorology	Applied Meteorology	Agricultural Meteorology	3
		Satellite and Radar Meteorology	3
	Dynamic Meteorology	Tropical Meteorology	2
		Atmospheric Dynamics	3
		Atmospheric Thermodynamics	3
	Weather and Climate Forecasting	Weather Analysis and Forecasting	3
		Numerical Weather Prediction	2
		The Science of Climate Change	3
Hydrology	Applied Hydrology	Applied Hydrology	3
		Irrigated Lands Hydrology	2
		Groundwater Hydrology	3
	Hydrological Extremes	Hydrological Analysis and Forecasting	3
		Flood and Drought	2
	River Basin Management	River and Sediment Transport	3
		Soil and Water Conservation	2
		Water Resources Assessment and Planning	3

6. Test Blueprint (Table Specification) for BSC in Meteorology and Hydrology

Themes and Share of the themes in %	Name and Share of the Courses in %	Cr.Hr.	General objective/Competency	Specific objectives /learning outcomes	Learning outcomes								No. of items
					Cognitive						Affective	Psychomotor	
					Remembering	Understanding	Application	Analysis	Evaluation	Creation/ Synthesis			
Applied Meteorology Share of the theme I : 14%	Agricultural Meteorology Share of the course in theme I: 7	3	Students will integrate the field of meteorology with plant physiology, plant pathology, hydrology and soil sciences.	Students will be able to describe the role of temperature, wind and humidity on crop germination, growth and yield	1	1	1						3
				Students will be able to describe weather factors conducive to infection of plants	1	1							2
				Students will be able to describe the effect of soil temperature and soil moisture on plant growth		1	1	1	1				4
	Satellite and Radar Meteorology Share of the course in theme I: 7	3	Students will develop a broader knowledge on the basic Satellite and Radar Meteorology principles such as data collection, processing, interpretation, digital images	Students will be able to describe fundamental of remote sensing	1	1							2
				Students will be able to describe passive sensors-Lidar radar and speckles									
				Students will be able to describe general characteristics of polar orbiting and geosynchronous satellites.	1	1							2
				Students will be able to use satellite imagery to identify meteorological and hydrological systems.		1	1	1					3

			and their analysis.										
				Students will be able to describe the working principle of radar; types of meteorological radars; acquisition and interpretation of data from weather radar.			1		1				2
Applied Hydrology Share of the theme II : 16.3%	Applied Hydrology Share of the course in theme II: 6.1	3	Students will develop a broader knowledge on hydrology as both a science and as an engineering practice, particularly as related to its application in water resources management and estimation.	Students will be able to describe rainfall runoff relationship (Rational method; SCS curve number; Time Area method; Hydrograph analysis, Effective rainfall, abstraction (Phi-index, infiltration, SCS), Base flow separation and Synthetic unit hydrographs).		1			2				3
				Students will be able to describe hydrological model development approaches and classification.	1								1
				Students will be able to describe frequency analysis (probability distributions, flow duration curve, risk and reliability analysis).			1						1
				Students will be able to describe methods and types of flood routing.					1				1
				Students will be able to describe types of reservoir and methods reservoir capacity determination		1							1
			Students will	Students will be able to describe irrigation method and design		1							1

	Irrigated Lands Hydrology Share of the course in theme II: 4.1	2	develop a broader knowledge on the fundamental concepts of irrigation, soil-water-plant relationships, and application of hydrological knowledge to irrigation design and distributions	Students will be able to analyze crop water requirements and irrigation schedule.									
				Students will be able to describe drainage of irrigated lands; salt and water logged problems in irrigated agriculture.			2						2
				Students will be able to design unlined and lined canals		1							1
	Groundwater Hydrology Share of the course in theme II: 6.1	3	Students will understand the occurrence, distribution and movement of water below the surface of the earth and develop skills in groundwater exploration and development.	Students will be able to describe the concepts related to groundwater occurrences, groundwater storage, recharge and discharge.						2			2
				Students will be able to estimate the groundwater flow direction, flow rate and hydraulic properties of aquifers.	1								1
				Students will be able to describe the methods and ways to locate site for water well drilling.			2						2
				Students will be able to demonstrate the concept of isotope hydrology for groundwater (recharge, source and age).									
Dynamic Meteorol	Tropical Meteorology	2	Students will develop in-depth knowledge of	Students will be able to describe main characteristics of tropical weather and climate.	1								1

ogy Share of the theme III : 18.6%	Share of the course in theme III: 4.6		meteorological processes occurring in the tropics.	Students will be familiar with the Inter-tropical Convergence Zone (ITCZ) (observational aspects of the ITCZ; ITCZ theory; trade wind regimes; trade wind inversion).		1							1
				Students will be able to describe tropical weather systems and tropical variability (easterly waves; west African disturbance lines, tropical upper tropospheric troughs, Tropical Easterly jet stream, East African low level jet; heat lows; the Somali jet, Quasi-biennial oscillation (QBO); Madden-Julian Oscillation (MJO); El-Nińo-Southern Oscillation (ENSO).					1				1
				Students will be familiar with types and characteristic features of monsoons; and their role in tropical climate.			1						1
				Students will be able to describe weather systems affecting Ethiopia during local seasons; seasonal rainfall variability and drought over Ethiopia.		1		1					2
	Atmospheric Dynamics Share of the course in theme III: 7	3	Students will develop understanding of the dynamical behavior of the atmosphere, the governing equations that govern	Students will be able to describe different types of coordinate systems.	1								1
				Students will be familiar with fundamental forces acting in the atmosphere (pressure gradient force; coriolis force; centripetal acceleration and centrifugal force; gravitational force; viscous force; Archimedes and buoyancy forces) and their derivation.		1		1					2

			atmospheric behavior and forces acting in the atmosphere.	Students will be able to carry out derivation and scale analysis of the equation of motion; and apply basic laws of conservation.			1	1	1				3
				Students will be able to demonstrate knowledge of horizontal frictionless flow (inertial flow; cyclostrophic flow; the gradient wind approximation; geostrophic wind; the thermal wind; ageostrophic wind). Students will be familiar with the circulation theorem, its physical interpretation and application; with vorticity theorem and its application.		1			1				2
	Atmospheric Thermodynamics Share of the course in theme III: 7	3	Students will develop a broader knowledge on the fundamental thermodynamic principles, laws and equations; and apply them to deal with atmospheric problems and determine the thermal structure of basic atmospheric phenomena.	Students will be able to describe the ideal gas law; Avogadro's hypothesis; Boyle's law; Dalton's law	1								1
				Students will be able to explain the first law of thermodynamics.		1							1
				Students will be able to explain the second law of thermodynamics (the Carnot cycle; entropy; statement of the second law of thermodynamics; special forms of the second law; combining the first and second laws.		1	1						2
				Students will be able to describe thermodynamic properties of water- vapor pressure (saturation vapor pressure, Van derWaals equation; equilibrium phase transformations - latent heat; The Clausius – Clapeyron equation; approximations and				1					1

				consequences of the C–C equation									
				Students will be able to describe measures and description of moist air (isobaric cooling – dew and frost temperatures; adiabatic isobaric processes – wet-bulb temperatures; adiabatic expansion (or compression) of unsaturated moist air; reaching saturation by adiabatic ascent; saturated ascent; saturated adiabatic lapse rate).					1				1
				Students will be able to use and interpret thermodynamic diagrams (the Tephigram (T-ϕ); the Emagram; the Skew T - ln P diagram; graphical representation of thermodynamic variables in a T - ln p diagram).				1	1				2
Hydrological Extremes Share of the theme IV: 14%	Hydrological Analysis and Forecasting Share of the course in theme IV: 8.4	3	Students will develop a broader knowledge on hydrological analysis methods and forecasting techniques.	Students will be familiar with fitting a probability distributions and methods of probability distributions for hydrological variables.									
				Students will be familiar with basic principles of statistics for hydrological analysis.	1		2						3
				Students will be able to analyze of river flow and use of river flow information (empirical frequency distributions (flow duration curves) and its use; time series analysis)		1							1
				Students will be familiar with aspect of rain floods forecasting system, flood forecasting methods and models.				2					2
	Flood and	2	Students will	Students will be able to recognize the types of drought									

	Drought Share of the course in theme IV: 5.6		understand the basic knowledge of hydrologic extremes, i.e. Floods and drought; their characteristics, impacts, and mitigation mechanisms.	and their estimation techniques.									
				Students will be able to summarize hydro-climatic hazards (floods, drought, thunderstorms, wind gusts, tidal waves, TCs, hurricanes, tornados, frost, and heat waves; El Nino Events).	2								2
				Students will be able to study floods and droughts in Ethiopia.			1	2					3
				Students will be able to establish the data requirements for disaster preparedness and modeling hydrologic extremes.	1								1
				Students will be able to understand the organization of early warning and response systems		1							1
Weather and Climate Forecasting Share of the	Weather Analysis and Forecasting Share of the course in theme V: 7	3	Students will gain in-depth knowledge of practical experience in weather analysis techniques, forecasting techniques and interpretation of available numerical forecast products.	Students will be able to understand coding and decoding of weather messages (SYNOP, SHIP, TEMP, PILOT and SATOB).	1				1				2
				Students will be able to analysis of surface and upper-air weather charts by drawing isoclines (isobars, contours, streamlines, isotachs and isotherms) and identify different weather systems (hot center, troughs, ridges, cyclones, anticyclones, jet streams, convergence and divergence, rising and sinking motion of air, cold and warm air mass and fronts).		1		1					2

theme V : 18.6%				Students will be introduced to weather forecasting techniques:- subjective, statistical and numerical weather prediction; problem and progress of weather forecasting; types of forecasts - time scale, content and performance; climate prediction techniques; forecast verification.			2	1					3
	Numerical Weather Prediction Share of the course in theme V: 4.6	2	Students will be introduced to the basic understanding of Numerical Weather Prediction (NWP), processes and components.	Students will be familiar with understand Finite Differencing Methods (forward and backward differencing; centered finite differencing; the Laplacian and Jacobian operators; Time Differencing Schemes: Euler Scheme, Leap Frog Scheme, Adams Bashforth Scheme, Implicit Schemes; space & time differencing and their Stability)	1								1
				Students will be familiar with objective analysis and data assimilation (polynomial approach and Cressman's method; Barnes' Objective Analysis Scheme)		1	1	1					2
				Students will be introduced to NWP Models (grid point and spectral models; hydrostatic and non-hydrostatic models; barotropic models , equivalent barotropic model and baroclinic model Primitive Equation (PE) model).			1	1	1				3
	The Science of Climate Change	3	Students will gain in-depth knowledge on the science of climate and the dynamics of the underlying components of	Students will be able to distinguish climate variability and climate change; the climate system and component of the climate system; climate forcing: external forcing, short-term forcing; feedback process in the climate system: water vapor feedback, Ice-albedo feedback,	1	1							2

	Share of the course in theme V: 7		the climate system.	cloud feedback.									
				Students will be able to understand the role of atmospheric gases in global warming: origin of the greenhouse effect: ‘primary’ and ‘secondary’ effects; properties of greenhouse gases; the lifetime of a greenhouse gas in the earth’s atmosphere, CO2 variations in changing climate	1	1							2
				Students will be familiar with concept of radiative forcing; aerosols, land use changes; direct and indirect Global Warming Potentials (GWPs); the Global Temperature Potential (GTP); CO2 equivalent (CO2-e); detection and attribution of climate change: internal climate variability, external forced climate variability.				1					1
				Students will be familiar with observed climate variability and climate change: change in land and sea surface temperature; changes in spatial distribution of surface temperature (ST); trends in tropospheric temperature; changes in the cryosphere; changes in extreme events; changes in snow, ice and frozen ground; changes in river, lake and sea ice; changes in glaciers and ice capes; observed and projected climate change in Ethiopia			1	1	1				3
				Students will be familiar with the concepts and implementations of climate change mitigation and									

				adaptation: mitigation methods; Wedge strategies currently available; climate change adaptation, adaptation policy: needs and issues; different components of adaptation and resilience; reactive and proactive adaptation; international adaptation efforts to date; adaptation under the UNFCCC; climate insurance.									
River Basin Management Share of the theme VI : 18.6%	River and Sediment Transport Share of the course in theme VI: 7	3	Students will be familiar with the basic concept and engineering behavior of rivers and their sediment transport processes to address the practical challenges in river engineering.	Students will be able to understand the concepts of river morphology, watershed forms, and river formation.	1								1
				Students will be able to determine bed form type, dimensions, and sediment load.			2						2
				Students will be able to calculate bed shear stresses, bed shear velocity, discharge, Chezy coefficient, and average velocity.			1	1					2
				Students will be able to identify sediment transport type and their modes of motion.		2							2
				Students will be able to describe the river training structures that control sediment problems.		1							1
	Soil and Water Conservation Share of the course in theme VI: 4.6	2	Students will apply soil and water conservation knowledge to obtain the maximum sustained level of land by preventing soil	Students will be able to understand the components, phases, and physical, chemical, and biological properties of soil.	1								1
				Students will be able to determine the particle size of soil.			2						2
				Students will be able to recognize soil and water management interventions to control (prevent and reduce) losses of soil and water on a field		1							1

			degradation and environmental pollution.	and watershed scales.									
				Students will be able to describe the concept of wind and water erosion.		1							1
				Students will be able to demonstrate various water harvesting techniques.		1							1
	Water Resources Assessment and Planning Share of the course in theme VI: 7	3	Students will be able to apply mathematical optimization methods and models to the planning, design, and operation of water resources development systems.	Students will be able to describe water resource systems.		1							1
				Students will be able to identify optimization algorisms (Direct Search Methods, Optimization using Lagrange Multiplier; Linear Programming, LP Applications, Dynamic Programming, Multi-objective Optimization)	1		2						3
				Students will be familiar with basic concepts of reservoir operation and management, reservoir sizing.		1							1
				Students will be familiar with phases of project analysis, project performance criteria & evaluation techniques economic principles evaluation techniques.		1		1					2
				Students will be familiar with integrated river basin development; water supply and demand assessment; types of consumptive and non-consumptive uses of water resources; single and multipurpose water-uses-compatibility of different uses.		1							1
				Students will be familiar with water rights and water laws; the concept of the master plan; Ethiopian water resource basins.		1							1
													120

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

7. 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.

8. Appendix: Share of Themes/Courses/Items in Percent

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	1		3	3/6 = 0.5	0.5*17 = 9	2	3	2	1	1	-	-	-	9
	2		3	3/6 = 0.5	0.5*17 = 9	2	3	2	1	1	-	-	-	9
Share = 17 items from the total	Theme one total credit		**6**											
Theme Two	1		3	3/8 = 0.375	0.375*22 = 8	1	2	3	2	-	-	-	-	8
	2		2	2/8 = 0.25	0.25*22 = 6	-	2	-	2	-	2	-	-	6
Share = 22 items from the total	3		3	3/8 = 0.375	0.375*22 = 8	1	2	2	2	-	1	-	-	8
	Theme two total credit		**8**											
Theme Three	1		2	2/8 = 0.25	0.25*22 = 6	1	2	1	1	1	-	-	-	6
	2		3	3/8 = 0.375	0.375*22 = 8	1	2	1	2	2	-	-	-	8
Share = 22 items from the total	3		3	3/8 = 0.375	0.375*22 = 8	1	2	1	2	2	-	-	-	8
	Theme three total credit		**8**											
Theme Four			**3**	3/5 = 0.6	0.6*14 = 8	1	3	2	2	-	-	-	-	8
			2	2/5 = 0.4	0.4*14 = 6	1	2	1	2	-	-	-	-	6
Share = 14 items from the total	Theme four total credit		**5**											
Theme Five			**3**	3/8 = 0.375	0.375*22 = 8	1	1	2	2	1	1	-	-	8
			2	2/8 = 0.25	0.25*22 = 6	1	1	1	2	1	-	-	-	6
Share = 22 items from the total			**3**	3/8 = 0.375	0.375*22 = 8	2	2	1	2	1	-	-	-	8
	Theme five total credit		**8**											
Theme Six			**3**	3/8 = 0.375	0.375*22 = 8	1	3	3	1	-	-	-	-	8
Share =			**2**	2/8 =	0.25*22 = 6	1	2	3		-	-	-	-	6

22 items from the total				0.25										
			3	3/8 = 0.375	0.375*22 = 8	1	3	3	1	-	-	-	-	8
	Theme six total credit		**8**											
Total for the program			43			18	35	28	25	10	4			120

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