



Ministry of Education

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

Program: - Program: B.Sc. In ElectroMechanical 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.

Blue print 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.

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 of ElectroMechanical 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.

Therefore, the main purpose of this manual is to give direction on how to develop Exit Exam questions for respective course specialists, so that they can develop a test or questions items for Electromechanical Engineering program.

1.1 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 Electromechanical engineering 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.

1.2 Objectives of the Exit Examination

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 Electromechanical Engineering
- Ensuring whether the graduation profile of the Electromechanical Engineering curriculum has achieved standards of knowledge and practical skills
- Improving stakeholders' trust and confidence in ElectroMechanical Engineering 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 Higher Education Institutions satisfy the requirements of the labor market and employability through the national wide implementation of competency-based exit exam
- Creating competitive spirit among Electro-mechanical Engineering departments and professionals in Ethiopia with the vies to encouraging them to give due attention to the national standards

2. Expected Profile of Graduates'

Bachelors in Electromechanical Engineering program meant to produce competent graduates that are able to heavily take part in the above professional fields, systems and activities. Therefore, Electromechanical Engineering program is intended to equip the student with:

- A sufficiently broad and deep base of mathematics, physical sciences, and engineering sciences;
- Broad knowledge of Electrical and Mechanical engineering systems, machineries and control systems;
- Excellent knowledge of design and manufacturing theories supported by laboratory exercises, workshop practices, and industrial internship;
- Sufficient practices in the use of computers, mechatronics devices and application of software related to the field;
- Sufficient knowledge of management concepts and communication skills, etc. In short, the program should give due emphasis to the integration of knowledge and skill to enable its graduates enter the profession.

3. Competencies and Learning Outcomes

3.1 Competencies

Electromechanical Engineering is concerned in designing, analyzing, troubleshooting, as well as modifying, maintaining, and repairing of Electromechanical equipment, components, systems, and subsystems, ranging from micro-machines to powerful industrial robots by developed knowledge, skills and attitude in industrial automation, robotics, control systems, machining, various actuators, safety, mechatronics, programmable logic controllers (PLCs), automation welding , machine elements and computer-control methods.

Table 1: competencies and learning outcomes

Competencies	Learning outcomes
Engineering Knowledge	✓ Understand appropriates advanced mathematical, material science, fluid mechanics, engineering thermodynamics principle & numerical methods to analyze problems related to electromechanical systems, and formulate numerical related computer programs and use suitable software related to computational and numerical techniques. ✓ Apply thermodynamic concepts to describe the performance of the individual components of an engineering system, e.g. a power plant, a jet

	engine, etc., and then relate that information to the overall performance of the entire system. ✓ Use various types of measurement, the functions of measuring sensors, transducers, instruments, and their usage ✓ Modeling dynamic systems, and establish equations of motion for them to solve dynamic problems in electromechanical system. ✓ Understand operating principles of machinery and systems, and prepare specification of electromechanical units. ✓ Analyze, interpret, and produce electrical, electronic, and mechanical drawings and other related documents and graphic
Problem analysis and design of solutions (skills)	✓ Identify, formulate, and analyze complex Electromechanical engineering problems to design their solutions, develop systems and processes that meet specified needs with appropriate consideration for public health, safety, and environmental considerations using principles of science and Electromechanical engineering. ✓ Design, install, maintain and make sustainable operation of steam generation systems, power plants, ventilation, refrigeration and air-conditioning systems, energy recovery equipment and heat exchangers. ✓ Develop major instrumentation data acquisition systems and electronic support equipment used for different application. ✓ Evaluate & select the composition, shape and dimensions of machine elements that fulfill functional and strength requirements. ✓ Design different machine components & drive mechanisms. ✓ Design, Model and implement Control systems with appropriate controller for various applications and systems. ✓ Execute original designs for electromechanical elements and integrate the elements into a system composed of several elements. ✓ Design, prototype and development of electromechanical systems. ✓ Provide technical support and documentation to enable customer to gain

	the most from the new systems and features. ✓ Determine lay-out of machineries; supervise machine installation and maintenance of electromechanical systems.
Attitude	✓ Optimize production costs & energy utilization in plants and design, and install HVAC (Heating, Ventilation and Air Conditioning) systems. ✓ Ensure all work in accordance with relevant law, policies, codes, regulations, safety procedures, and standard shop practices. ✓ Develop personal and professional strategies and plans to improve job performance and work relationships with clients, coworkers, and supervisors. ✓ Communicate effectively and technically with in scientific community and stake holders. ✓ Recognize the need for and have the preparation as well as ability to engage in an independent and lifelong learning in the information and knowledge economy.

3.2 Learning Outcomes

The main program outcomes of B.Sc. degree in Electromechanical engineering are the following:

- Complete working knowledge of the fundamental principles that support ElectroMechanical Engineering.
- Design and conduct experiments, as well as analyze and interpret data.
- Design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.
- Ability to function in a multidisciplinary team.
- Ability to identify, formulate and solve engineering problems.
- Ability to communicate effectively.
- The broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context.
- Engage in life-long learning and knowledge of contemporary issues.

- An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

4. Selected course for Exit Exam of ElectroMechanical Engineering

Based on the graduation profile, competency, and skills, eleven courses are selected. The exam will focus on the main key of the courses.

- a.** Strength of Materials
- b.** Fluid Mechanics
- c.** Engineering Thermodynamics
- d.** Machine Elements
- e.** Theory of Machines and Mechanisms
- f.** Design of Electromechanical systems
- g.** Introduction to Electrical Machines
- h.** Industrial Automation and control
- i.** Measurement and Instrumentation Engineering
- j.** Embedded Systems
- k.** Power electronics and Electrical drives

5. Category of Courses into Themes

The courses are categorized into five main themes. Those are based on the area of course contents as well as their engineering fields.

Category 1: Engineering Mechanics

- Strength of Materials

Category 2: Thermo-Fluid Engineering

- Fluid Mechanics
- Engineering Thermodynamics

Category 3: Machinery Design

- Machine Element
- Theory of Machines and Mechanisms

Category 4: Industrial Automation and control

- Design of Electromechanical systems
- Introduction to Electrical Machines
- Industrial Automation and Control
- Measurement and Instrumentation Engineering

Category 5: Electronics and embedded systems

- Embedded Systems
- Power electronics and Electrical drives

6. Courses to be Included in the Exit Examination

This document has been compiled with **5 themes** and **11 courses** for exit examination for achieving the competencies level of graduates that are expected to acquire. In Electromechanical under graduate program there is plenty numbers of courses; but the core courses are clearly presented and have been selected in this document. Accordingly, this exit examination document has identified **11 courses** delivered at different semesters and academic calendars.

S. No	List of Themes	List of courses	Cr.hr
1	Engineering Mechanics	Strength of Materials	3
2	Thermo-Fluid Engineering	Fluid Mechanics	3
		Engineering Thermodynamics	3
3	Machinery Design	Design of Machine Elements	6
		Theory of Machines and Mechanisms	3
4	Industrial Automation and control	Industrial Automation and Control	3
		Measurement and Instrumentation Engineering	3
		Design of Electromechanical systems	6
		Introduction to Electrical Machines	6
5	Electronics and embedded systems	Embedded Systems	3
		Power electronics and Electrical drives	3
Total Cr.hr			42

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Industrial Automation and control	Industrial Automati on and control	3	43	17	8	1	2	3	1	1				8
	Measurement and Instrumentation Engineering	3		17	7	1	1	2	1	1	1			7
	Designof Electrom echanical systems	6		33	14	1	3	5	2	2	1			14
	Introducti on to Electrical Machines	6		33		1	3	4	3	2	1			14
Total			18											
Electronics and embedded systems	Embedde d Systems	3	15	50	7	1	3	2	1					7
	Power electroni cs and Electrica l drives	3		50	8		4	1	2	1				8
Total			6											
Total		42				7	29	24	22	13	4		1	100

7. Conclusion

Exit examination can have a vital role in producing knowledgeable, skillful and attitudinally matured graduates. 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 Electromechanical Engineering program. To meet the graduation profile, competency and learning outcome, exit exam competency selection and identifying core course was done for 2015 EC Electromechanical Engineering graduating students. As a result, preparing test blueprint for Electromechanical Engineering is necessary to prepare fairly distributed items based on the above criteria.

Appendix

Themes	Course Name	General objective	Learning outcomes	Learning outcomes							
				Cognitive							
				Remembering	Understanding	Application	Analysis	Evaluation	Creation/Synthesis	Affective	Psychomotor
Engineering Mechanics	Strength of Materials	Calculate the induced stresses in a rigid body which is subjected to various load and loading conditions; & determine the allowable strength of components subjected to load.	Basic concepts in mechanics of materials;		1	1					
			Stability criteria of compression members;		1						
			Strength and deformation calculations of loaded members;			1	1				
			Design methods of simple machine members.				1	1			

Thermo-Fluid Engineering	Fluid Mechanics	provides basis for understanding fluid behavior for engineering design and control of fluid systems and to determine resultant interactions of flows and engineered and natural systems	• permits students to understand the basic concepts, principles, laws, observations, and models of fluids at rest and in motion, • Provides basis for understanding fluid behavior for engineering design and control of fluid systems, • Understand the principles of operation of flow measuring instruments, conduct measurements, evaluate the data and draw conclusions • Enables students learn methods for computing head losses and flows in simple pipes and channels.	1	2						
			• Identify, formulate and solve engineering problems involving compressible fluid flows • Newtonian and no-Newtonian flows, Enables students to learn the nature of rotation, circulation, resistance (viscous, turbulent), boundary layers, and separation with applications to drag and lift on objects, and			1	1				

			• Explain about the Modes of heat transfer. • State and explain the Laws of Thermodynamics • Explain about Rankine cycle with reheating and superheating • Explain the concept of entropy				1				
Machinery Design	Design of Machine Elements	Design, evaluate & select the composition, shape and dimensions of machine elements that fulfill functional and strength requirements.	• Identification or selection of proper safety factor to avoid failure before the expected life of the component; • Fatigue life and fatigue strength of machine elements; • Causes of stress concentration in machine elements;		3			1			
			• Analysis of the strength of bolted, welded, riveted and interference fitted joints; • Design of keys, splines and pins; • Analysis of pressure vessels, valves and sealing mechanisms; Design of springs.			2	1		1		

			The course enables students understand basic principles of design in the design and analysis of typical machine elements with particular focus on: Shafts, Couplings, Clutches and Brakes; Drives: Friction Drives, Belt Drives, Chain Drives and Gear Drives; and Bearings.		1			3	1			1	
	Theory of Machines and Mechanisms	Modeling dynamic systems, and establish equations of motion for them to solve dynamic problems in electromechanical	Describe different types of linkage mechanisms and their layout used in mechanical design	1	1								
			Analyze kinematics and kinetic mechanisms and design of machinery		1			1					
			Provide knowledge on the cause for vibration and to perform vibration analysis by developing a mathematical model for vibration analysis				1	1	1				
	Industrial Automation and Control	Design, Model and Control implement systems with appropriate	Understand and develop different controllers for different applications	1									
			- To design and Analyze process control loops - To develop complex process loops using P and ID symbols		1	1		1					

Industrial Automation and control			- Learn about the some specialized sub-systems like Programmable controllers and their programming techniques, SCADA systems, Remote Terminal - Units, fuzzy logic controllers, smart sensors and field bus.		1	1		1				
			- Learn about the important aspects of interfacing real world (analog and digital) signals and actuators with PC. - Learn that Distributed Digital Control is an important field, which has come in a big way in all industrial control applications			1						

Introduction to Electrical Machines	Understand the basic principles of electromechanical energy conversion devices, understand inrush currents, harmonics and conditions for parallel operation and design aspects of transformers, Understand dynamic equations and control aspect of D.C machines and understand D.C. armature winding & A.C. windings.	- To understand basic concepts of electromagnetic circuits as they relate to voltages, currents, and physical forces induced in conductors. - To understand and gain insight into principles of operation & construction of transformer, induction machines, - To learn and understand analytical models for transformers and electrical rotating machines.	1	1						
		- To use such models to analyze power requirements, power capability, efficiency and operating characteristics, - To learn and understand inrush currents, harmonics and conditions for parallel operation and design aspects of transformers - IM models to analyze power requirements, power capability, efficiency and operating characteristics, torque		1	2	1	1	1		

			- To learn and understand D.C. armature winding. - To understand dynamic equations and control aspect of D.C machines. - To understand salient pole synchronous machine features, reference frame transformation, d-q axis theory, power/load angle relationship and carry out transient analysis. - To understand the principle of operation and construction of fractional horsepower motors.									
	Measurement and Instrumentation Engineering	Use various types of measurement, the functions of measuring sensors, transducers, instruments, and their usage	- Understand the measurement of resistance, inductance & capacitance using different bridges like, Whetstone's bridge; Anderson's bridge & Schering Bridge. - Understand the construction of different electronic measuring instrument's	1	1							
			- There are different techniques for measuring power & related Parameters. - Classify the transducers depending on the principle of operation. Realize that the main objective of this subject is to impart a solid application oriented Knowledge of the technology spanning the Industrial control instrumentation.			1		1	1			

			- Understand the construction and working of transducers to measure temperature, Pressure, flow, force, torque, speed, level and density. - Select an appropriate transducer for a specific process parameter measurement			1	1					
	Design of Electromechanical systems	Design, prototype and development of electromechanical systems.	- Explain; what is meant by mechatronics and appreciate its relevance in engineering design, a system and define the elements of measurement systems and the various forms and elements of open-loop and closed-loop control systems. - Understand the design process as applied to mechatronics system, which featured electrical, mechanical and computational components. - To introduce the basic technique of signal conditioning.	1	1		1	1				

			- Understand and familiar with electromechanical devices. - To understand electrical and mechanical actuation system. - Describe; the basic structure of a microprocessor and microcontroller system, the architecture of common microprocessor and how they can be incorporated in microprocessor systems and the basic structure of microcontrollers.		2		1	1			
			- Familiar with electro mechanical devices and micro manufacturing techniques - Able to build their own electro mechanical project.			5			1		
Electronics and embedded systems	Embedded Systems	Understand fundamentals of digital system components and their design	Explain the fundamental differences between microprocessors and microcontrollers.	1	2						
			Use microcontrollers for any application in the real world, which involves interfacing microcontrollers to the real time systems		1	1					

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