



Ministry of Education

**Identified Competency Focus Areas and Core Courses for Ethiopian
Higher Education Institutions' Exit Examination**

Program: - Mechanical Engineering in BSc.

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1. Introduction

Mechanical Engineering is a profession that deals with the design, manufacturing, selection, installation, commissioning, operation, and maintenance of all forms of machinery, equipment, and industrial systems. The profession plays a vital role in the establishment and sustainable operation of a nation's manufacturing industries, transport systems, power generation, construction, and mining industries.

Professional mechanical engineers could have the following involvement:

- ✓ Product design, development, and manufacturing;
- ✓ Industrial plant design, equipment selection, plant erection, commissioning, operation, and maintenance;
- ✓ Industrial gas- and water-supply system/component design;
- ✓ Automotive and construction equipment design and maintenance;
- ✓ Energy conversion system/component design, installation, commissioning, operation, and maintenance;
- ✓ Heating, refrigeration, air-conditioning system/components design, installation, commissioning, operation, and maintenance;
- ✓ Industrial project design and evaluation;
- ✓ Project management;
- ✓ Factory and technical service management in the capacity of general manager, technical manager, operation manager, maintenance manager, and sales manager.

To assure those professionals, an exit exam may help a university make pertinent decisions to improve the quality of institution-wide education and, in some cases, can help assess the standard of education in specific courses. Exit exams are also regarded as helpful in instituting a system of accountability and transparency through which students, instructors, higher education institutions, and academic leaders can be measured for their success or failure, based on student outcomes.

Based on the graduation profile, competency, and learning outcomes, some courses are considered to be included in the exit exam.

1.1 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 Mechanical Engineering
- Ensuring whether the graduation profile of the Mechanical Engineering curriculum has achieved at least common standards of knowledge and practical skills
- Improving stakeholders' trust and confidence in Mechanical 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 HEIs satisfy the requirements of the labor market and employability through the national wide implementation of competency-based exit exam
- Creating competitive spirit among Mechanical Engineering departments in Ethiopia with the vies to encouraging them to give due attention to the national standards

1.2 Significance of the Document

It is important to set competency areas of the subject matter (program) in order to measure how much graduates have acquired skills, knowledge, and attitudes. The following shows us the significance of setting competencies and identifying core courses of the program;

- To set competencies that help to assess the basic skills, knowledge, and attitude of graduating students;
- To systematically identify the core courses which will be included in the exit exam;

2. Expected Profiles of Graduates'

Due to his/her strong background, a B.Sc. mechanical engineering graduate can accomplish the following tasks after a brief period of on-job training:

- Represent machine and parts drawing manually and/or with CAD software.
- Understand operating principles of machinery and systems and prepare the specification.
- Design small machinery, piping, and other systems
- Conduct strength analysis of machine components
- Plan production process and assembly of parts
- Determine and optimize production costs
- Determine the layout of machinery and supervise machinery installation.
- Manage the maintenance of equipment
- Control the quality of products.
- Optimize energy utilization in plants.
- Manage the operation of thermal systems, energy conversion and HVAC systems.
- Design, develop, operate, and maintain material handling equipment.

3. Competencies and Learning Outcomes

The Mechanical Engineering profession can be acquired and mastered by graduates who are well educated to enter into and dedicate to continue growing in the profession.

3.1. Core Competencies

The core competency of mechanical engineering related to skills, attitude and knowledge in an undergraduate degree program acquires many requirements. An undergraduate Mechanical Engineering program meant to produce such graduates must be designed to provide the students with a sufficiently broad and deep base of the following requirements:

3.1.1 Knowledge Requirement:

- Advanced mathematical techniques of calculus, differential equations and numerical methods
- Fundamentals of Engineering Sciences, phenomena, and relationships of solid mechanics and thermo-fluids, including their limitations.
- Knowledge of Engineering Graphics and CAD.

- Working knowledge of engineering materials.
- Knowledge of machine elements and their respective design procedures.
- Knowledge of metal fabrication processes and assembly processes.
- Knowledge of designing products, usage, and repairing of machines tools, material handling equipment, process equipment, fluid machines, power generation systems, refrigeration, air conditioning, and steam generation systems.
- Exposure to electrical and electronic circuits and machines.
- Principles of operation of control systems and their essential components
- Knowledge of relevant standards, codes, and regulations.
- Knowledge of maintenance procedures of machinery
- Knowledge of the industrial principles of maintenance management
- Principles and practices of personnel management and supervision.
- Principles of plant layout design
- Basic concepts of technical management and accounting, including project management and evaluation, material management and the like.
- Basic concepts of product costing.
- Knowledge of appropriate technologies in the local context.

3.1.2 Technical Abilities and Skills

- to analyze needs and requirements when designing products
- to design a system, component, or process to meet user needs
- design, sequence, and schedule production process of product
- to operate relevant computer software for design/analysis/optimization
- to determine the tools and equipment needed to do a job
- to interpret written directions, specifications, plans, and drawings
- to write specifications for mechanical and electrical equipment
- Testing and inspection of products or processes, and evaluating quality or performance.
- to determine compliance of products with specifications
- to identify, formulate, and solve engineering problems
- to design and conduct experiments, as well as to analyze and interpret data

- Engineering material identification/ prescription while differentiating availability and suitability
- inspection and commissioning of equipment
- to plan, control equipment maintenance, and determine life cycle costs
- to use fault diagnosis tools and non-destructive testing
- to estimate and analyze product or service costs
- Drafting skill

Analytical/Computational skills

- to apply mathematical analysis and computational methods for solving engineering problems
- to apply modeling, simulation, and visualization techniques to mimic the system behavior for predictive control and to test different solutions

3.1.3 Attitudes

1. Problem Identification through root-cause analysis
2. Problem-solving using cause-effect relationships, logical thinking, and an open mind (overcoming mental blocks).
3. to comprehend the scheme of things when configured/reconfigured assembled/disassembled by visualization.
4. to group together things or actions in a specific order/pattern using a specific rule/set of rules.
5. Understanding the implications of new information for both current and future problem-solving and decision-making.
6. The ability to apply general rules to specific problems to produce a reasonable solution.
7. The ability to combine pieces of information to form general rules or conclusions.
8. Considering the relative costs and benefits of potential actions to choose the most appropriate one.

Managerial abilities/Behavioral skills

- to plan, organize, coordinate and control the work of subordinates
- to set priorities and assign work to other professionals.
- to maintain records, prepare planning and performance reports.
- to tell when something is wrong or is likely to go wrong.
- Identifying measures or indicators of system performance and the actions

- needed to prove or correct performance, relative to the goals of the system
- Managing one's own time and the time of others
- Motivating, developing, and directing people as they work, identifying the best

3.2. Major Learning Outcomes

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

- Complete working knowledge of the fundamental principles that support Mechanical 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 Mechanical Engineering

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

Courses

1. Engineering Materials (I & II)
2. Strength of Materials (I & II)
3. Manufacturing Engineering (I & II)
4. Fluid Mechanics
5. Heat Transfer
6. Engineering Thermodynamics (I & II)

7. Mechanism of Machinery
8. Instrumentation and Measurement
9. Introduction to Mechatronics
10. IC Engine and Reciprocating Machines
11. Machine Elements (I & II)
12. Turbomachinery
13. Refrigeration and Air Conditioning
14. Maintenance of Machinery (Maintenance of machinery and Installation)
15. Industrial Management and Engineering Economy
16. Materials Handling Equipment

5. Category of Courses into Themes

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

NB. The category might not indicate as the courses are in the same module.

5.1 Category 1: Engineering Mechanics and Materials

- ❖ Engineering Materials (I & II)
- ❖ Strength of Materials (I & II)

5.2 Category 2: Engineering Thermo-Fluid System

- ❖ Fluid Mechanics
- ❖ Heat Transfer
- ❖ Refrigeration and Air Conditioning
- ❖ Engineering Thermodynamics (I & II)

5.3 Category 3: Control Engineering

- ❖ Instrumentation and Measurement
- ❖ Introduction to Mechatronics

5.4 Category 4: Machinery Design and Energy Conversion

- ❖ IC Engine and Reciprocating Machines
- ❖ Machine Elements (I & II)
- ❖ Turbomachinery

- ❖ Mechanism of Machinery
- ❖ Materials Handling Equipment

5.5 Category 5: Manufacturing, Maintenance and Industrial Management

- ❖ Manufacturing Engineering (I & II)
- ❖ Maintenance of Machinery
- ❖ Industrial Management and Engineering Economy

6. Conclusion

To meet the graduation profile, competency and learning outcome in the profession of mechanical engineering, exit exam competency selection and identifying core course for undergraduate mechanical engineering is drafted for 2015 E.C graduates. The exam will contain sixteen courses in five themes. The exam will be given to thirty-six higher education institutes. The elective courses in the streams under the mechanical engineering program are **excluded** and major courses only are considered.