



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

Band I: Engineering and Technology

Program: - Bachelor of Science Degree in Biomedical Engineering

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January, 2022
Ministry of Education
Bahirdar, Ethiopia

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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.

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 addition to 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 document is to provide details on blueprint for content so respected programs, in this scenario its biomedical engineering.

Undergraduate programs in Biomedical Engineering are currently run in four universities, namely Addis Ababa University, University of Gondar, Jimma University, and Hawassa University. Accordingly, 10 courses categorized into 5 program themes have been recommended to be covered in the proposed exit exam to start by the end of 2022/23 academic year. The currently identified competency areas are valid for 2022/23 academic year only. The document will be revised for the 2023/24 academic year due to implemented Harmonized curriculum for all universities.

2. Objective of test blueprint

Test blueprint prepared is generally opted to assist the preparation of a test that is representative, broadly sampled, and consisting of complete knowledge domain expected of the Biomedical Engineering 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

- Understand the basic scientific basis and principles of biomedical equipment's including the application of diagnostic and therapeutic biomedical equipment in the health care delivery.
- Design, develop and manufacture medical devices and systems or processes to meet desired needs within economic, environmental, social, political, ethical, health and safety, manufacturability and sustainability constraints.
- Apply knowledge of healthcare technology management and assessment of medical devices starting from planning, technology assessment, specification, procurement, installation, training, operation, maintenance to decommissioning and disposal to improve quality of healthcare service provision in the healthcare facilities.
- Develop and ensure implementation of standards, regulatory frameworks and requirements relevant to medical devices function
- Develop the attitude and mind-set up to apply medical and engineering ethics to provide the necessary professional services.
- Support the Government in the development of guidelines, directives, and policies relevant to biomedical engineering and technology.
- Train and mentor healthcare staff on operational, proper handling of biomedical equipment.
- Undertake innovation through research to adopt and adapt simple and appropriate biomedical technologies for efficient and effective healthcare services
- Have the interpersonal skills that help work as a team of healthcare staff and interaction with clients and other stakeholders
- Become entrepreneurs in the areas of specification, design, installation, operation, and maintenance of biomedical equipment

4. General objective

The general objectives are:

- To produce skilled and competent manpower to national and international market
- 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

5. Specific Objectives (Learning outcomes)

- Understand the basic concepts in bio-materials, and apply to biomedical engineering applications.
- Understand the basic concepts in bio-mechanics, and apply to biomedical engineering applications.
- Understand the basic concepts in bio-fluid mechanics and apply to biomedical engineering applications.
- Understand various electrical and non-electrical biological signals produced by the body and different ways of collecting, processing and measuring those signals.
- Understand standard biomedical instrumentation hardware required for reliable diagnosis and treatment of patients in the healthcare system.
- Evaluate the safety and efficiency of medical devices
- Provide technical and end user training on healthcare technologies
- Develop, configure, Install, operate, adjust, maintain and calibrate healthcare technologies
- Understand, develop, install, configure, maintain and operate standard medical imaging technologies including image processing software required for reliable diagnosis and treatment of patients in the healthcare system,

- Design, prototype and develop Biomedical devices
- Acquire the knowledge, skill, and attitude to carry out research for design and implementation of biomedical systems in any healthcare environment including hospitals, clinics, and health centers
- Skill to develop medical equipment specification, procurement, inventory, install dispose appropriate healthcare technologies required for hospitals, clinics, and health centers and familiarize with engineering and medical ethics accepted by the professional community to effectively manage hospital engineering functions.
- Understand the basic knowledge about hospital engineering functions, design, hospital architecture and facilities

6. Themes and list of courses

1. Basic Biomedical Engineering: Understand the basic concepts in bio-physics, bio-optics, bio-materials, bio-mechanics, and bio-fluid mechanics to be utilized in major biomedical engineering tracks including biomedical instrumentation and imaging systems, healthcare technologies.
2. Biomedical Instrumentation and Processing: Understand, develop, install, configure, and operate standard biomedical instrumentation hardware with relevant signal processing software required for reliable diagnosis and treatment of patients in the healthcare system
3. Biomedical Imaging: Understand, develop, install, configure, maintain and operate standard medical imaging technologies including image processing software required for reliable diagnosis and treatment of patients in the healthcare system,
4. Biomedical System Design: Acquire the knowledge, skill, and attitude to carry out research for design and implementation of biomedical systems in any healthcare environment including hospitals, clinics, and health centers
5. Healthcare Technology Management and Hospital Engineering: Acquire the knowledge, skill, and attitude to specify, procure, inventory, install, operate, maintain, calibration, dispose appropriate healthcare technologies required for hospitals, clinics, and

health centers and familiarize with engineering and medical ethics accepted by the professional community to effectively manage hospital engineering functions.

Courses to be included in the exam

- ✓ Biomaterials
- ✓ Biomechanics
- ✓ Bio-fluid Mechanics
- ✓ Biomedical Signal Processing/ BioSignal Processing
- ✓ Biomedical Instrumentation
- ✓ Biomedical Workshop Practice / Bioinstrumentation Lab
- ✓ Biomedical Imaging Systems/Medical imaging Modality
- ✓ Biomedical Design/ BME Computer Application+ BME prototype
- ✓ Healthcare Technology Management
- ✓ Hospital Engineering

Table 1: Themes with total ECTS

Theme	Courses	ECTS
1. Basic Biomedical Engineering	Biomaterials	4
	Biomechanics	4
	Bio-fluid Mechanics	3
	Total	11
2. Biomedical Instrumentation and Processing	Biomedical Signal Processing/ Bio Signal Processing	5
	Biomedical Instrumentation	10
	Biomedical Workshop Practice / Bioinstrumentation Lab	4
	Total	19
3. Biomedical Imaging	Biomedical Imaging Systems/Medical imaging Modality	5
4. Biomedical System Design	Biomedical Design/ BME Computer Application+ BME prototype	6
5. Healthcare Technology	Healthcare Technology Management	5
	Hospital Engineering	5

Management and Hospital Engineering	Total	10
Themes Total ECTS		51

Table 2: Share of the Themes/Courses/Items in Percentage (%)

Themes	Course Name	Learning outcomes	ECTS	Weight of course or proportion	Number of test items from each course	Cognitive						Affective	Psychomotor	Total
						Remember	Understand	Apply	Analyze	Evaluate	Create			
Theme One Share = 21 %	1		4	4/11 = 0.363	0.363*21= 8	-	3	3	2	-	-	-	-	8
	2		4	4/11= 0.363	0.363*21 = 8	-	1	1	2	2	1	-	1	8
	3		3	3/11 = 0.272	0.272*21 = 6	1	2	-	2	1	-	-	-	6
	Theme one total ECTS		11											
Theme Two Share = 37 %	1		5	5/19 = 0.263	0.263*37 = 10	-	3	2	2	2	-	-	1	10
	2		10	10/19=0.526	0.526*37 = 18	4	4	3	2	2	1	1	1	18
	3		4	4/19 = 0.210	0.210*37 = 8	-	-	1	1	2	-	1	3	8
	Theme Two total ECTS		19											
Theme Three Share = 10%	1		5	5/5 = 1	1*10= 10	2	2	1	1	2	1	-	1	10
	Theme three total ECTS		5											
Theme Four share =12%			6	6/6=1	1*12=12	-	2	3	2	-	3	-	2	12
	Theme four total ECTS		6											
Theme five share =20%	1		5	5/10=0.5	0.5*20=10	2	2	2	-	2	-	2	-	10
	2		5	5/10=0.5	0.5*20=10	2	2	2	-	-	2	2	-	10
Theme five total ECTS			10											
Total ECTS for the program			51			11	21	18	14	13	8	6	9	100

Test Blueprint (Table Specification) for BSC in Biomedical Engineering

Themes	Name of Courses	ECTS	Share of the themes in %	General objective	Specific objectives	Learning outcomes								No. of items
						Cognitive						Affective	Psychomotor	
						Remembering	Understanding	Application	Analysis	Evaluation	Creation/Synthesi			
Basic Biomedical Engineering	Biomaterials	4	21	Using the principles of materials science and engineering to select appropriate biomaterials for particular engineering applications, using specified design criteria.	Understand the basic concepts in bio-materials,	-	3	-	2	-	-	-	-	5
					To apply biomaterial concept to biomedical engineering applications.	-	-	3	-	-	-	-	-	3
	Biomechanics	4		To introduce and analyze biomechanical principles using stress and strain, load and deformation, and material properties.	Understand the basic concepts in bio-mechanics	-	1	-	-	2	-	-	-	3
					To apply biomechanics concept to biomedical engineering applications.	-	-	1	2		1		1	5
	Biofluid mechanics	3		To Provide a basis for understanding biological fluid behavior for engineering design and control of fluid systems	Understand the basic concepts in bio-fluid mechanics	1	2	-	-	-	-	-	-	3
					To apply biofluid mechanics concept to biomedical engineering applications.	-	-	-	2	1	-	-	-	3
Biomedical Instrumentation and Processing	Biomedical signal processing/	5		To familiarize students with the various biomedical	Understand various electrical and non-electrical biological signals produced by the body and different ways of collecting,	-	3	2	2	2	-	-	1	10

	Biosignal processing		37	signal processing concept	processing and measuring those signals.									
	Biomedical Instrumentation	10		To equip students with various biomedical instrumentation concepts and principles of selected medical equipment	Understand standard biomedical instrumentation hardware required for reliable diagnosis and treatment of patients in the healthcare system.	3	2	-	-	2	1	-	-	8
					Evaluate the safety and efficiency of medical devices	1	2	-	2	-	-	1	-	6
					Provide technical and end user training on healthcare technologies	-	-	3	-	-	-	-	1	4
	Biomedical workshop practice/ Biomedical Instrumentation lab	4		To introduce students with hands-on practice with various healthcare technologies and procedures	Develop, configure, Install, operate, adjust, maintain and calibrate healthcare technologies	-	-	1	1	1	-	-	3	6
					To follow various safety procedure while working with healthcare technologies	-	-	-	-	1	-	1	-	2
Biomedical Imaging	Biomedical imaging systems/ Medical imaging modalities	5	10	To introduce students with different medical imaging modalities	Understand, develop, install, configure, maintain and operate standard medical imaging technologies including image processing software required for reliable diagnosis and treatment of patients in the healthcare system,	2	2	1	1	2	1	-	1	10
Biomedical System design	Biomedical Design/ BME Computer Application+ BME prototype	6	12	To acquire the knowledge to carry out research for design and implementation of biomedical system	To Design, prototype and develop Biomedical devices	-	2	1	1	-	1	-	1	6
					To acquire the knowledge, skill, and attitude to carry out research for design and implementation of biomedical systems in any healthcare	-	-	2	1	-	2	-	1	6

					environment including hospitals, clinics, and health centers									
Healthcare Technology Management and Hospital Engineering	Healthcare Technology Management	5	10	To present the essential tools and methods needed to effectively manage biomedical medical equipment that plays an essential role within a health service facility.	To acquire Skill to develop medical equipment specification, procurement, inventory, install dispose appropriate healthcare technologies required for hospitals, clinics, and health centers and familiarize with engineering and medical ethics accepted by the professional community to effectively manage hospital engineering functions.	2	2	2	-	2	-	2	-	10
	Hospital Engineering	5		To work effectively as a biomedical engineer in a hospital setting	To Understand the basic knowledge about hospital engineering functions, design, hospital architecture and facilities	2	2	2	-	-	2	2	-	10
Total						11	21	18	14	13	8	6	9	100

Identified Course content

1. Biomaterials

Properties of Biomaterials

- Mechanical Properties, Mechanical Testing, Surface Properties, Surface Characterization

Classes of Biomaterials

- Metals, Ceramics and Glasses, Bioresorbable, Biodegradable, Natural and Synthetic Polymers, Hydrogels, Silicon, Pyrolytic Carbon, Composites, Medical Fibers and Textiles

Host reaction to biomaterials

- Biocompatibility, Adsorbed Proteins, Cell Injury, Cell-Material Interactions, Toxicity, infection, inflammation, Innate Immune response, Adaptive Immune response, Foreign-body Response

Biological Testing of Biomaterials

- Variability, Cell Culture in vitro Assays, Blood Compatibility Tests, Polymer Degradation, Biological degradation, Metallic Corrosion, Ceramic Degradation

2. Hospital Engineering

Modern hospital architecture & electrical power system

- Classification of hospitals
- Elements and division of hospitals
- Morphology and design of modern hospital
- Electrical power systems in hospitals
- Standby power systems
- Emergency and standby power system

Equipment for maintaining patient health and comfort

- Sterilization
- Disinfection by heat, radiation and chemical
- Refrigeration
- Air conditioning

Management and safety of facilities

- Types of medical gases (O₂, N, N₂O, NO, HE, Xenon)

- Components of central gas supply system
- Centralized supply of oxygen
- centralized vacuum system

3. Healthcare Technology management

Introduction to HTM

- Planning and Assessment.
- Budgeting and Financing.
- Technology Assessment and Selection
- Procurement and Logistics.
- Installation and Commissioning.
- Training and Skill Development
- Operation and Safety
- Maintenance and Repair
- Decommissioning and Disposal

4. Medical Imaging Modalities

- Ultrasonics
- X-ray imaging
- CT scanning
- Magnetic resonance imaging
- Other imaging techniques

5. Bioinstrumentation

- Biopotential, Biopotential amplifiers, Biopotential electrodes, transducer
- Bioelectric signals
- Measurement of non-electrical parameters (BP, Temperature, Blood flow)
- Microscope
- Patient Monitors & ECG
- Suction machine
- Autoclave
- Oxygen concentrator
- Anesthesia machine
- Mechanical Ventilator
- Hematology machine

- Defibrillator and external pacing
- Dialysis machine
- Endoscopy

6. Biomedical Workshop Practice / Bioinstrumentation Lab

Safety management

- Personal protective equipment (PPE)
- Electrical safety
- Biological safety
- Radiation safety

Troubleshooting process

Troubleshooting of selected medical equipment

- Microscope
- Centrifuge
- Suction machine
- Autoclave
- Oxygen concentrator
- Patient monitoring & ECG

7. Biomedical Design/ BME Computer Application+ BME prototype

Design process

- Product planning
- Concept generation
- Design selection
- Procurement and specifications
- Prototype
- Test

Simulation and manipulation of electronic circuits

- Simulation of electronic circuit using Proteus
- Arduino microcontroller

Introduction to Basic CAD software

8. Biomedical Signal Processing/ BioSignal Processing

Introduction to Bio-signal Processing

- Classification of Signals
- Discrete Time Signals

- Basic Discrete Time signals(sequences)
- Classification of Discrete Time Signals
- Discrete Time Systems
- Input Output Description of Systems
- Basic Operation of Discrete Time Systems
- Classification of Discrete Time Systems
- Linear Time Invariant Systems
- Frequency Domain Representation of Discrete Time Signals and Systems
- Fourier Transform for Discrete Time Signals.
- The Z-transform
- Digital Filters
- Realization of Discrete-time systems
- Sampling
- ECG Signal Processing

9. Biofluid Mechanics

Introduction

- Brief history of BFM,
- Nature of Fluids;
- Fluid Properties; Viscosity;
- Pressure and pressure measurement

Fluid Flow

- Basic equations of Fluid flow; Bernoulli's equation.
- Application of conservation of mass & momentum in systems with fluid flow.
- Different types of fluid flows, laminar and turbulent flow,

Pressure and Flow in Blood Vessels

- Introduction to cardiovascular system,
- Blood flow in veins and blood flow in capillaries.

10. Biomechanics

- Introduction to biomechanics
- Biomechanics of bones (hard tissue) and musculoskeletal tissues
- Biomechanics of Joint

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.

In view of this, this document is produced to assist the setting of the exit examinations for Biomedical engineering, which is being delivered by Jimma University, Addis Ababa University, Gondor University and Hawassa university under 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.