Ministry of Education

Identified Competency Focus Areas and Core Courses for National Exit Examination

Program: Bachelor of Science in PHYSICS

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July, 2022
Addis Ababa
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1. Introduction

Physics, as one of the fundamental sciences, is concerned with the observation, understanding and prediction of natural phenomena and the behavior of man-made systems. It deals with profound questions about the nature of the universe and with some of the most important practical, environmental and technological issues of our time. The scope of Physics is broad and encompasses mathematical and theoretical investigations, experimental observations, computing techniques, technological applications, and material manipulations. Physics seeks simple explanations of physical phenomena based on universal principles stated in concise and powerful language of mathematics. The principles form a coherent unity, applicable to objects as diverse as DNA molecules, neutron stars, super-fluids, and liquid crystals. Discoveries in Physics have implications in all walks of life ranging from the way we perceive reality to gadgets of everyday use. Physicists constantly test the basic laws of nature by probing the unknown, the mysterious and the complex. They also search for new laws at the frontiers of knowledge, systematically seek novel properties of matter.

In principle the current educational trends emphasize graduate profiles (attributes, knowledge and skills) that enable students keep abreast of the progress in science and technology, and utilize their knowledge and skills to solve real-physical problems. Based on this the graduates are expected to fulfill the minimum learning competency and considerable learning outcomes. Therefore as per the guideline given by MOE the graduates are expected to take an exit exam as of 2015 E.C. in cognizant to the following rational.

The perspective of taking "fitness for purpose" to conceptualize quality education in higher education has vividly become an increasingly difficult task. Of the many competing ingredients, educational achievement is still considered a major determinant attribute of individual success in the labour market and for overall economic growth. By contrast, research studies indicate that central exit exams constitute an important feature of a system's institutional framework, which can hold students, teachers, schools, and administrators accountable for student outcomes. One potential way, therefore, to enhance educational achievement and quality of education is the introduction of exit exams. It could influence these outcomes by certifying or "signalling" that graduates have mastered a certain set of skills, giving them an advantage in both employment and earnings over students without such certification.

Thus, we have proposed 12 physics courses from which the question for the exit exam will be prepared. We selected these 12 physics courses from 29 compulsory physics courses in the BSc program by taking the courses that are common for BSc programs.

1.1 Objectives of the Exit Examination

The national Applied Physics 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 Physics courses.
- Ensuring whether the graduation profile of Physics BSc curriculum have achieved at least common standards of knowledge and practical skills
- Improving public trust and confidence in Applied Physics activities of Physics 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 Physics departments in Ethiopia with the aim of 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 the how much graduates are acquired with skills, knowledge and attitudes. The following shows us the significance or setting competencies and identifying core courses of the program;

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

2. Expected profiles of graduates

The Physics graduates are expected to acquire problem solving and abstract thinking skills. This makesPhysics graduates desirable professionals for various services and career over a wide range of scienceand technology innovation, development, critical thinking and decision making, modeling, constructinglaws, tracing laws and principles of natural laws to explain phenomena over a wide range of systems(from very small to very large system) including new discoveries and explorations. The graduates are expected to apply the knowledge and skill they obtained on new Science andTechnology applications and reforms for overall socio-economic development of the community. Furthermore, graduates will have basic knowledge and skills in teaching physics courses which will enable them to teach in senior secondary schools and higher learning institutions.

3. Competencies and learning outcomes

Theme	Minimum learning competencies	Learning outcomes
1.1 Mechanics (4 Chrs.)	• Will acquire basic knowledge in mechanics • Will acquire basic problem solving skills in mechanics • Will identify applications of mechanics in real life.	Graduates will be able to: • compute kinematical and dynamical related problem in 1D, 2D, and 3D. • solve problems related to work and energy. • calculate problems related to energy and momentum conservation. • solve problems relates to simple harmonic motion.
1.2: Fluid and thermal physics (3 Chrs)	• Will acquire basic knowledge in Fluid and thermal physics • Will acquire fundamental skills	Graduates will be able to: • explain and understand basic principles of fluid dynamics.

	in Fluid and thermal physics • Will identify applications of fluid and thermal physics	• comprehend the concept of temperature and heat to compute thermal expansion of solids and fluids • understand the kinetic theory of gases and laws of thermodynamics • measure temperature and heat quantities.
1.3: Classical mechanics (3 Chrs.)	• Will acquire basic knowledge in classical mechanics • Will acquire problem solving skills in classical mechanics	graduates will be able to: • relate motions in different coordinate systems, • obtain the velocity, acceleration and momentum in generalized coordinate, • develop the capability to determine the Lagrangian and Hamiltonian of mechanical systems.
2.1 Electromagnetism (4 Chrs.)	• Will acquire basic knowledge in Electromagnetism • Will acquire problem solving skills in Electromagnetism • Will acquire skills in constructing electrical circuits	Graduates will be able to: • explain the basic concepts of electric charge, electric field and electric potential and solve problems related to these concepts • solve problems related to electric circuits containing electrical elements (resistors, capacitors, inductors …) • understand Maxwell's equation in free space and media and solve problems related to Maxwell's

		equations • construct different types of electric circuits.
2.2 Electrodynamics I (3 Chrs.)	• Will acquire basic knowledge in Electrodynamics • Will acquire problem solving skills in Electrodynamics	Graduates will be able to: • solve different problems in electrodynamics, by applying different techniques. • understand and solve boundary value problems in electrodynamics, • comprehend electric circuits containing electrical elements (resistors, capacitors, inductors) • understand Maxwell's equation in free space and media and solve problems related to Maxwell's equations.
Introduction to Laser and Optics (3Crhs)	• Will acquire basic knowledge in optics and laser physics • Will acquire fundamental skills of solving problems related to optics and laser physics	`develop familiarity with historical development of laser Physics, • describe electromagnetic wave, • describe properties of light generated by laser, • develop understanding of the concept of modern and nonlinear optics, • explain the fundamental laws and principles applicable in laser, • elaborate some peculiar applications of laser, • understand the mechanism responsible for non-classical properties of light,

		• describe different sources of laser,
3.1 Modern Physics (3 Chrs.)	• Will acquire basic knowledge in Modern Physics • Will acquire problem solving skills to problems related to Modern Physics	Graduates will be able to: • apply the theory of Special Relativity to solve problems related to time dilation, length contraction, simultaneity, relativistic momentum, and relativistic energy. • apply quantum methods to solve problems involving atomic spectra, blackbody radiation, the photoelectric effect, X-ray emission and the structure of the atom.
3.2 Quantum mechanics I (3 Chrs.)	• Will acquire basic knowledge in Quantum mechanics • Will acquire fundamental skills of solving problem related to Quantum mechanics •	Graduates will be able to: • explain, compare and contrast the wave-particle characteristic of electromagnetic waves • elaborate the central concepts and principles of quantum mechanics • analyze the difference between the classical and quantum mechanical systems.

3.3 Nuclear physics (3 Chrs.)	• Will acquire basic knowledge in Nuclear physics • Will acquire fundamental skills of solving problems related to Nuclear physics • will acquire skills in applying nuclear physics to different applications (medicine, energy • will engage to proceed their education in the area of nuclear physics and nuclear engineering.	Graduates will be able to: • explain the key properties of nucleus in relation to the stipulated theoretical framework. • identify the excitation and ground state of a particle that may happen in the nucleus of an atom. • solve problems related to nuclear binding energy, fusion and fission or nuclear reaction.
4.1 Statistical physics (3 Chrs.)	• Will acquire basic knowledge in Statistical physics • Will acquire fundamental skills of solving problems related to Statistical physics	Graduates will be able to: • understand microscopic and macroscopic systems and processes, • apply basic statistical concepts required to describe physical systems for obtaining various mean values • identify Maxwell-Boltzmann, Bose-Einstein and Fermi-Dirac statistics in describing a given system.
4.2 Introduction to condensed matter physics (3 Chrs.)	• Will acquire basic knowledge in condensed matter physics • Will acquire fundamental skills of solving problems related to condensed matter physics	Graduates will be able to: • understand Crystal Structure and X-ray Diffraction, • describe binding energy in crystals • explain electronic band

		structure • describe vibration in molecules and crystals • explain the Free electron Fermi gas
4.3 Electronics (3 Chrs.)	• Will acquire basic knowledge in Electronics • Will acquire basic skills that enables him/her to design simple electronic devices	Graduates will be able to: • understand charge carrier generation in intrinsic and extrinsic semi-conductors; • explain various types of diodes, IV characterestics of diodes and some application of diodes as recetifier. • analyze the basic principles of bipolar junction transistor (BJT) circuit in various configuration (common emitter, common base and common collector) • construct simple electronic devices

4. Categorization physics courses into themes

Theme 1: Classical Physics

1.1 Mechanics
1.2 Fluid and thermal physics
1.3 Classical mechanics

Theme 2 Electromagnetic theory

2.1 Electromagnetism
2.2 Introduction to laser and optics
2.3 Electrodynamics I

Theme 3: Quantum physics

3.1 Modern Physics
3.2 Quantum mechanics I
3.3 Nuclear physics

Theme 4: Condensed matter physics

4.1 Statistical physics
4.2 Introduction to condensed matter physics
4.3 Electronics

5. Physics courses to be included in the exit exam

1. Mechanics
2. Fluid and thermal physics
3. Electromagnetism
4. Modern Physics
5. Nuclear physics
6. Electronics
7. Quant mechanics I
8. Electrodynamics I
9. Classical mechanics
10. Statistical physics
11. Introduction to condensed matter physics
12. Introduction to laser and optics

6. Conclusion

As it is well known there is a great intension to improve the graduate profiles of the BSc Physics graduates to meet the required demand of the country. A strong background in Physics is necessary for careers in quality education, industry and energy sector. Thus, it is imperative that students be equipped with strong Physics knowledge, skills and attitudes which enable them to be productive and capable. In line with this, in order to qualify the knowledge, skills, and attitudes

of the graduates with respect to the BSc curricula 12 compulsory physics courses are selected for the anticipated national exit examination. This is a validated document.

7. Remark:

The following compulsory courses are excluded since they are not offered in the BSc programs of the Adama Science and Technology University.

1. Physics of Oscillations and Waves
2. Introduction to relativity
3. General Astronomy
4. Quantum Mechanics II
5 Electrodynamics II

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