UMBC Department of Physics, General Education Courses (GEC)

I. Desired Learning Outcomes

All GEC courses offered by the Physics Department address the Scientific and Quantitative Reasoning competency. In particular, their goal is that the students should be able to:

1. Understand and use mathematical and scientific methods of inquiry, reasoning, processes, and strategies to investigate and solve problems.
2. Organize, interpret, draw inferences, and make predictions about natural or behavioral phenomena using mathematical and scientific models and theories.

The Physics GEC courses along with their specific desired learning outcomes are:

PHYS 100, Ideas in Physics.

By the end of the semester a student should be able to:

1. Describe the basic classical physics concepts in mechanics, electricity and magnetism, and thermal physics.
2. Use these concepts in explaining how the physical world functions in specific, simple situations.
3. Describe how solutions to simple problems can be generalized to more complex situations.
4. Critically examine other's analysis and recognize miss-use of scientific analysis.

PHYS 105, Ideas in Astronomy.

By the end of the semester a student should be able to:

1. Describe the basic astronomical concepts and the underlying physics of matter, energy and laws of motion governing the behavior we observe in the heavens.
2. Use these concepts in explaining the key points in how astrophysical systems function.
3. Understand basic astronomical nomenclature.
4. Understand new results and the current key questions in astronomical research today.
5. Understand time and spatial perspectives in the Universe.

PHYS 106, Introduction to Astrobiology.

By the end of the semester a student should be able to:

1. Describe the wide variety of carbon-based life on Earth.
2. Provide an overview of the formation, planetary science, and biological processes that made Earth habitable.
3. Describe the search for evidence of past (or current) life elsewhere in our Solar System, particularly on Mars.
4. Describe current ideas as to whether life may be present elsewhere in the universe.

PHYS 111, Basic Physics 1.
By the end of the semester a student should be able to:

1. Qualitatively and quantitatively reason with definitions of distance, displacement, speed, velocity, and acceleration.
2. Create and interpret graphs of position vs. time, velocity vs. time, and acceleration vs. time.
3. Solve problems related to one-dimensional and two-dimensional motion.
4. Identify forces and draw free-body diagrams, calculate components and vector sums of forces.
5. Apply Newton's laws of motion to solve problems involving conservative and non-conservative forces and motion.
6. Apply equilibrium conditions to extended objects to determine unknown forces and torques.
7. Apply conservation of energy to solve problems involving energy transfers and transformations for a system.
8. Apply the first law of thermodynamics and the ideal gas law to solve problems relating to thermal processes for ideal gases.
9. Apply properties of fluid pressure and Archimedes' principle to solve problems relating to buoyancy.

PHYS 112, Basic Physics 2.
By the end of the semester a student should be able to:

1. Apply the charge model to explain basic electric phenomena.
2. Use Coulomb's law to calculate vector properties (magnitude and direction) of electrical forces between charged particles, and electric fields of charged particles.
3. Calculate electric potential and electric potential energy of discrete charge configurations, and apply conservation of energy to solve problems.
4. Apply Ohm's law to calculate resistance, current, voltage and power in circuits.
5. Apply Kirchhoff's laws to analyze series and parallel configurations of circuits containing batteries, resistors and capacitors.
6. Calculate the magnetic fields due to moving charges, and currents in wires of different geometries, namely, straight wire and loops.
7. Calculate the magnetic forces on moving charges and on current-carrying wires in magnetic fields.
8. Understand general characteristics of waves on strings, sound waves and light waves.
9. Apply the principle of wave superposition to the phenomena of interference.
10. Understand and apply the laws of reflection and refraction.
11. Use the thin-lens equation to analyze image formation by lenses and mirrors.

PHYS 121, Introduction to Physics 1.

By the end of the semester a student should be able to:

1. Solve 1-dimension and 2-dimention kinematics motion problems
2. Characterize the basic properties of vector and apply superposition principle
3. Apply Newton's laws to solve problems related to motion and force
4. Apply energy principle to solve mechanics problems
5. Apply conservation of momentum to solve problems related to collision
6. Apply Newton's 2^{nd} law for rotation to solve rotational dynamics problems
7. Solve problems related to static equilibrium
8. Apply conservation of angular momentum to solve problems
9. Apply Newton's laws and energy principle to solve problems related to simple harmonic motion

PHYS 122, Introduction to Physics 2.

By the end of the semester a student should be able to:

1. Apply the first law of thermodynamics, ideal gas law, and ideas of molar heat capacity to thermal processes with ideal gases.
2. Analyze the performance of thermodynamic cycles.
3. Use Coulomb's law and the principle of superposition to find electric fields of charged particles and determine forces on charged particles.
4. Apply Gauss's law to find electric fields of symmetric charge distributions and infer charge distributions on conductors.
5. Qualitatively and quantitatively reason with electric potential and electric potential energy; determine electric potential difference from electric field.
6. Apply the definition of capacitance and Kirchoff's rules to find charges and voltages in circuits containing batteries and capacitors.
7. Apply Ohm's law and Kirchoff's rules to find currents, voltages, and power in circuits containing batteries and resistors.
8. Analyze charging and discharging processes in circuits containing batteries, resistors, and capacitors, i.e, determine charges, currents, and voltages as a function of time and in limiting cases of small and large times.
9. Determine the magnetic force on a moving charge particle and its resulting motion, the magnetic force on a current-carrying wire, and apply ideas of torque and potential energy to current loops in magnetic fields.
10. Apply results of the Biot-Savart law and the superposition principle to determine magnetic fields due to infinite straight wires and current loops.
11. Apply Faraday's law to determine the emf arising from a changing magnetic flux.

PHYS 121H, Introduction to Physics 1 for Honors College and Physics Majors.

By the end of the semester a student should be able to:

1. Demonstrate their knowledge of the following course content

a. Basic properties of vector and their application to physical quantities
b. 1-dimension and 2-dimention kinematic motion
c. Newton's laws and the relationships between motion and force
d. Energy principles in mechanics
e. Conservation of momentum principles related to collision
f. Apply Newton's 2nd law for rotation applied to rotational dynamics
g. Static equilibrium
h. Conservation of angular momentum
i. Newton's laws and energy principle applied to simple harmonic motion

2. Explain mechanical phenomena in simple physical terms

3. Use sketches and diagrams to examine mechanical situations and reduce them to a simple model

4. Analyze these models using the course content

5. Carry a sustained mathematical analysis to completion

PHYS 122H, Introduction to Physics 2 for Honors College and Physics Majors.

By the end of the semester a student should be able to:

1. Demonstrate their knowledge of the following course content

a. Heat and the first law of thermodynamics applied to the ideal gas and thermal processes
b. Entropy and the connection between macroscopic and microscopic states of systems
c. Thermodynamic cycles applied to heat engines
d. Coulomb's law, electric fields, and the use of the principle of superposition to find forces and fields produced by discrete and distributed charges
e. Gauss's law
f. Electric potential and electric potential energy
g. Batteries, resistors, and capacitors
h. Kirchoff's rules in simple dc-electrical circuits
i. Charging and discharging processes in simple RC circuits
j. Biot-Savart law and production of magnetic fields
k. Magnetic forces on moving charges and current-carrying wires

l. Faraday's law applied to the creation of emf
m. Inductors
n. Simple LRC circuits

2. Explain phenomena based on this material in simple physical terms

3. Examine thermodynamic situations and reduce them to a simple model

4. Examine electrical and magnetic situations and reduce them to simple models

5. Analyze these models using the course content

6. Be able to carry a sustained mathematical analysis to completion

II Direct Assessment of the GEC courses learning goals.

To directly assess the level at which the learning goals of each course are achieved and to identify weak points, a series of targeted questions and problems will be incorporated in the clicker questions, the homework, the mid-term, and final exams. The results of these assessments will directly contribute to evaluating the Scientific and Quantitative Reasoning competency of the students.

III. Indirect Learning Outcome Assessment

A questionnaire for each key course will be filled by the students at the end of the semester. The questionnaire will list the learning goals asking the students to evaluate by grading in a scale from 1 to 5, with 5 been the highest grade, the degree to which each learning goal have been achieved. It will also allow students to provide suggestions for changes in the course.

IV. Using the Results of Assessments for Departmental Action

As part of the Physics Department Self Assessment Program, the instructor of each GEC course will file a report with the departmental self-assessment committee describing the degree to which the learning goals have been achieved, identifying possible weak points, if any, and proposing ways to fix them. The assessment committee will use the instructor's feedback, along with the end of the semester questionnaires, to determine if any changes in the curriculum or teaching methods would be desirable. An annual faculty meeting will be devoted to evaluating the data obtained through the learning outcome assessment actions discussed above and recommending the implementation of necessary changes in the curriculum or teaching methods. After approval by the faculty, the changes will be implemented by the Undergraduate Program Director. After the faculty meeting, the assessment committee will prepare a report that the Chair of the Department will use to inform the Dean of the College of Natural and Mathematical Sciences.