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Undergraduate Physics at Hampton University

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Undergraduate Physics at Hampton University

Background: Graduate Program

- **Private University funded through an endowment
~5500 Undergraduates and ~ 600 Graduate Students**
- **14 Faculty, ~12 Postdocs, ~6 Research Faculty**
- **~40 Graduate Students and ~20 Majors**
- **Research Programs:
Nuclear Physics, Laser Spectroscopy,
Laser Remote Sensing, Nanomaterials,
High Energy Physics (CERN)
Medical Physics Program (EVMS)
Proton Beam Cancer Therapy Treatment Facility**





Undergraduate Physics at Hampton University

Background: Undergraduate Program (Pre 2004)

- **250 Biology students per semester in non-calculus based physics**
- **130 Engineering, Chemistry, Mathematics, Physics, and Architecture students in calculus based physics**
- **Typical upper level courses**

Problems:

- **Physics Majors were not prepared to fully take advantage of the introductory physics course.**
- **This propagated throughout their matriculation through the program.**
- **Their scientific writing and oral presentation skills were not developing at the appropriate level.**





Undergraduate Physics at Hampton University

Systemic Problems:

- **The first semester of physics required majors to use math skills that they would not attain through the math curriculum until much later.**
- **This lack of math preparation caused majors to struggle unnecessarily in the upper level physics courses.**
- **There was no organized approach to developing students' scientific methods and oral presentation skills.**
- **The student enrollment for physics was based primarily on walk-ons.**

Objective:

- **Fix these four problems for the physics majors.**





Undergraduate Physics at Hampton University

Strategies:

- **Create an honors calculus-based physics course that would require a co-requisite honors computational physics course.**
- **Create a computational physics course for the sophomore year in order to prepare students for Mechanics, E&M, and Quantum.**
- **Create a four-year seminar course that would prepare students for scientific writing and oral presentations.**
- **Create a senior capstone thesis course that would require students to complete a bachelor's thesis on original research written in *AIP Style Manual* format, and would require students to present an oral defense.**

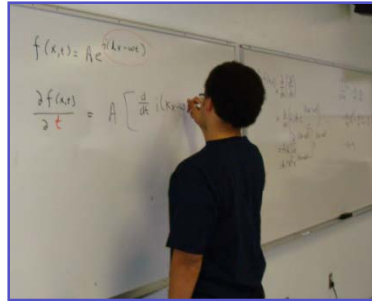




Undergraduate Physics at Hampton University

Freshman Year

Introductory Physics with Calculus I & II
Introduction to physics using advanced mathematical approaches including calculus and differential equations.



Computational Physics I & II
Basic techniques for mathematical and computer modeling of physical systems with emphasis on topics in introductory physics.

Experimental Physics I & II
Introduction to experimental physics, computerized data acquisition, and statistical data analysis.

Communication in Physics I & II
Provides a discussion of physics topics by students, faculty and invited speakers. Emphasis is placed on developing writing and presentation skills.



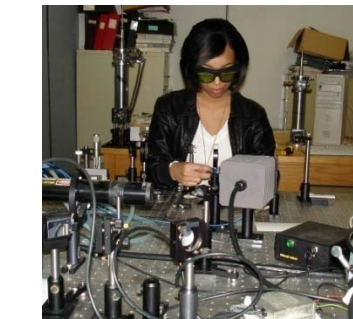
Sophomore Year

Modern Physics I & II
Introduction to relativity, quantum structure of atoms, atomic spectra, Schrodinger's equation, nuclear models, radioactive decay, solid state physics and elementary particles.

Computational Physics III & IV
Advanced techniques for mathematical and computer modeling of physical systems with emphasis on topics in modern physics, mechanics, thermodynamics, electrodynamics, and quantum physics.

Experimental Physics III & IV
Advanced techniques in experimental physics with emphasis on topics in modern physics.

Communication in Physics III & IV
Provides a discussion of physics topics by students, faculty and invited speakers. Emphasis is placed on developing writing and presentation skills.





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Junior Year

Mechanics I & II

Advanced treatment of Newton's laws oscillatory motion, central-force problems and Hamiltonian and Lagrangian dynamics.

Thermodynamics (2nd semester)

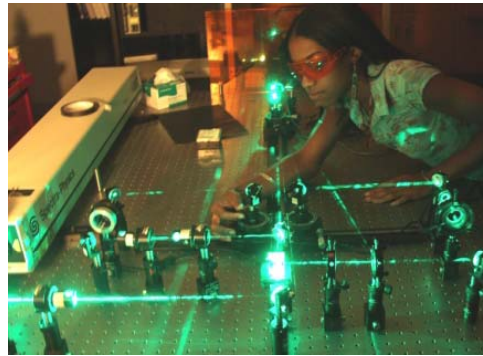
Introduction to thermodynamic systems, equations of state, first and second laws of thermodynamics, kinetic theory, heat engines, and statistical mechanics.

Electrodynamics I & II

Advanced treatment of electrostatics, dielectrics, electric currents, electromagnetic induction, magnetic fields, Maxwell's equations, boundary-value problems, vector wave equations, and electromagnetic radiation from accelerated charges.

Communication in Physics V & VI

Provides a discussion of physics topics by students, faculty and invited speakers. Emphasis is placed on developing writing and presentation skills.



3 Technical Electives

Students headed to graduate school in physics use these electives to obtain a minor in mathematics, etc.

Senior Year

Quantum Mechanics I & II

General formalism of quantum mechanics including: state space, Dirac notation, matrix mechanics, angular momentum, ideal particles and the exclusion principle, many electron atoms, the periodic table, Fermi and Bose gases, and perturbation theory.

Communication in Physics VII

Provides a discussion of physics topics by students, faculty and invited speakers. Emphasis is placed on developing writing and presentation skills.

Capstone Thesis

(Not Required for the Pre-Med Option)

Students complete an in-depth technical report based on independent physics related research. The thesis is written in standard American Institute of Physics format and bound copies are retained by the university, the advisor and the student.





Undergraduate Physics at Hampton University

Communications in Physics

Communication in Physics I - VII

- Provides a discussion of physics topics by students, faculty and invited speakers.
- Emphasis is placed on developing writing and presentation skills.
- Department faculty give talks on their research providing the students with an introduction to the various research being performed on campus.
- Invited speakers recruit for graduate schools, offer summer internships or other opportunities, or provide information on careers.
- The physics “family” is promoted; class camaraderie is established; and retention is maximized.
- Involvement in campus events such as Honors College, and School of Science encouraged.
- Outreach – Rocket Club; Tutoring; Demonstrations.
- All students are placed in summer programs

Capstone Thesis

(Not Required for the Pre-Med Option)

- Seniors complete an in-depth technical report based on independent physics related research. Committee selected, proposal accepted.
- The thesis is written in standard American Institute of Physics format and bound copies are retained in the university library.



3 Technical Electives

Students headed to graduate school in physics use these electives to obtain a minor in mathematics, etc.





Undergraduate Physics at Hampton University

Curriculum Example

Freshman Physics Fall Schedule

Day	Intro Physics with Calculus I MWF-Noon	Day	Computational Physics I TTH-Noon	Day	Experimental Physics I W 2:00pm	Day	Communications in Physics I Th 4:00pm
M W F	Significant Figures/Units Kinematic Motion Kinematic Motion	T TH	Algebra Algebra and Trigonometry	W	Introduction to Data Studio Laboratory Safety	Th	Organizational Meeting SPS Meeting
M W F	Kinematic Motion Kinematic Motion: Kinematic Motion	T TH	Trigonometry and Vectors Vectors	W	Introduction to Data Studio Laboratory Safety	Th	Faculty Presentations
M W F	Test 1: Kinematic Motion Newton's Laws Newton's Laws	T TH	Logarithms and Exponentials Calculus: Derivatives	W	Position, Velocity and Acceleration	Th	Faculty Presentations
M W F	Newton's Laws Newton's Laws Test 2: Newton's Laws	T TH	Calculus: Derivatives/Integrals Calculus: Integrals	W	Projectile Motion	Th	Student Presentations SPS Meeting
M W F	Gravity Gravity/ Kepler's Laws Kepler's Laws	T TH	Conic Sections: Orbits Conic Sections: Orbits	W	Newton's Second Law	Th	Student Presentations
M W F	Test 3: Gravity Work and Energy Work and Energy	T TH	First Order Differential Equations Newton's Second Law: Differential Form	W		Th	Student Presentations
M W F	Conservation of Energy Conservation of Energy Test 4: Conservation of Energy	T TH	Newton's Second Law: Differential Form Newton's Second Law: Differential Form	W	Conservation of Energy	Th	Faculty Presentations SPS Meeting
M W F	Center of Mass and Momentum Conservation of Momentum Conservation of Momentum	T TH	Coordinate Systems Calculus: Center of Mass	W		Th	Student Presentations
M W F	Test 5: Momentum Rotational Kinematics Rotational Kinematics	T TH	Calculus: Impulse Integrals Multivariable Calculus:	W	Conservation of Momentum	Th	Student Presentations
M W F	Moment of Inertia Torque Angular Momentum	T TH	Multivariable Calculus: Moment of Inertia Multivariable Calculus: Moment of Inertia	W		Th	Faculty Presentations SPS Meeting
M W F	Test 6: Rotational Motion Static Equilibrium Static Equilibrium	T TH	Cross Products and Simultaneous Eqs. Complex Variables	W	Rotational Motion	Th	Student Presentations
M W	Fluids Thanksgiving	T	Second Order Differential Equations Thanksgiving	W	Hooke's Law	Th	Student Presentations
M W F	Fluids Test 7: Statics and Fluids Fluids/Sound	T TH	Simple Harmonic Motion Simple Harmonic Motion	W	Pendulum Motion	Th	Student Presentations
M W	Sound Temperature and Ideal Gas	T TH	Waves Oral Exams	W	Buoyant Force	Th	Student Presentations SPS Meeting





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Curriculum Example

Freshman Physics Spring Schedule

Day	Intro Physics with Calculus II MWF Noon	Day	Computational Physics II TTh Noon	Day	Experimental Physics II W 2:00pm	Day	Communications in Physics II 4:00pm
M	Temperature and Ideal Gas	T	Complex Variables	W	Temperature and Heat	Th	Organizational Meeting
W	Ideal Gas & Kinetic Theory	TH	Second Order Differential Equations				SPS Meeting
F	Ideal Gas & Kinetic Theory						
M	Holiday	T	Test 1: Complex Variables	W		Th	Faculty Presentations
W	Test 1: Ideal Gas and Kinetic	TH	Harmonic Oscillators				
F	Heat						
M	Heat	T	Harmonic Oscillators	W	Specific Heat	Th	Student Presentations
W	Heat Engines	TH	Harmonic Oscillators				
F	Heat Engines						
M	Entropy	T	Vectors 3D	W	Ideal Gas	Th	Student Presentations
W	Entropy	TH	Test 2: Harmonic Oscillators				
F	Test 2: Thermodynamics						
M	Charge	T	Cylindrical and Spherical Polar	W		Th	Faculty Presentations
W	Charge	TH	Multivariate Calculus				SPS Meeting
F	Gauss's Law						
M	Gauss's Law	T	Multivariate Calculus	W		Th	Student Presentations
W	Electric Potential	TH	Vector Calculus				
F	Electric Potential						
M	Test 3: Electrostatics	T	Vector Calculus	W	Ohm's Law	Th	Student Presentations
W	Capacitors	TH	Vector Calculus/Linear Algebra				
F	Resisters						
M	RC Circuits	T	Complex Variables	W	RC Circuits	Th	Faculty Presentations
W	Inductors	TH	Test 3: Gradient, Divergence and Curl				
F	RLC Circuits						
M	Test 4: Circuits	T	Cross Products	W	RLC Circuits	Th	Student Presentations
W	Magnetism	TH	Cross Products				SPS Meeting
F	Sources of Magnetism						
M	Sources of Magnetism	T	Waves	W	Sources of Magnetic Fields	Th	Student Presentations
W	Induction	TH	Waves				
F	Induction						
M	Test 5: Magnetism	T	Test 5: Cross Products	W		Th	Student Presentations
W	Maxwell's Equations	TH	Vector Calculus				
F	Maxwell's Equations						
M	Maxwell's Equations	T	Maxwell's Equations	W		Th	Student Presentations
W	Maxwell's Equations	TH	Maxwell's Equations				SPS Meeting
F	Test 6: Maxwell's Equations						
M	Reflection and Refraction	T	Test 6: Maxwell's Equations	W	Simple Lenses	Th	Senior Capstone Thesis Defense
W	Reflection and Refraction	TH	Geometry and Trigonometry				
F	Thin Lenses						
M	Interference	T	Special Functions: Diffraction	W	Superposition	Th	Senior Capstone Thesis Defense
W	Interference/Diffraction	TH	Test 7: Geometry, Trigonometry &				
F	Diffraction		Special Functions				
M	Test 7: Ch 32-35	T	Oral Exams				





Undergraduate Physics at Hampton University

Recruiting

Undergraduate
Physics
at
Hampton
University



SAT Student
Locator Service

Mailed about 700
Packets to prospective
students





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For more information
Contact Jan Mangana
Jan.mangana@hamptonu.edu
757.728.6908

<http://www.hamptonu.edu>

