Attachment 1

Interdisciplinary Applied Science and Mathematics Ph.D. Program

The following resolution is presented to the committee for approval and recommendation to the Board of Trustees for appropriate action:

RESOLUTION 14-

WHEREAS, Wright State University is proposing a new Ph.D. program in Interdisciplinary Applied Science and Mathematics designed to provide a workforce of skilled professionals trained in cutting edge interdisciplinary research fields; and

WHEREAS, the program has been approved by the Faculty Senate and the Provost; therefore be it

RESOLVED that the Ph.D. program in Interdisciplinary Applied Science and Mathematics, as submitted to this meeting be, and the same hereby is endorsed.

I offer this Motion:
Do I have a Second?
Roll Call Vote:

Program Development Plan for a new
Ph.D. Degree in Interdisciplinary Applied Science and Mathematics

1. Program Rationale and Purpose

Now and in the future, highly skilled workers are, and will continue to be in demand throughout the nation, and in Ohio in particular. Worldwide, economies must increasingly utilize technology to gain competitive advantage by developing new products, producing goods and delivering services ever more efficiently. In the Dayton area, the United States Air Force is a major driver of technology development. Wright Patterson Air Force Base (WPAFB) serves as a center for weapon systems acquisitions and aeronautical systems research. Local private sector companies engage in the development, production and marketing of new high tech devices. Faculty and graduate students at Wright State University (WSU) and the University of Dayton are actively involved in the basic and applied research on which new technologies will be based.

In order to bolster economic expansion, the state of Ohio and the federal government are investing heavily in technologically oriented research and development. There is widespread and growing recognition that important large-scale problems such as energy independence, global environmental stress remediation and medical care for an aging population will necessitate the active participation of scientifically sophisticated workers from a wide range of disciplines. To help train such skilled professionals, the proposed interdisciplinary Ph.D. program is structured around the following specific goals:

1. To prepare broadly trained, scientifically and technologically skilled professionals for careers in applied science in government and industry;
2. To provide a foundation for careers in basic scientific research;
3. To provide quantitative tools and knowledge to enhance workplace effectiveness;
4. To advance knowledge in basic and applied science and mathematics.

The proposed Ph.D. program is unique in its focus, building upon the recognized expertise of a core group of program faculty (See Appendix B.) within the College of Science and Mathematics (CoSM). The program focuses on three areas of technological and scientific importance:

1. <u>Nanoscale Science and Technology Development</u>: Sensor theory, biomolecular engineering, transport processes in noncrystalline materials, electromagnetic propagation in inhomogeneous media, spectroscopy, imaging, device physics.

2. <u>Modeling and Analysis for Physical and Biological Systems</u>: Nonlinear dynamics, complexity, transport processes, electromagnetic propagation, discrete dynamic systems, analysis under uncertainty, modeling of biological systems, cognitive modeling, mathematical models of perceptual processes, statistical techniques for the biomedical sciences, multi-scale physics.

3. <u>Computational Problems in the Physical and Biological Sciences</u>: Inverse problems, system optimization, computational statistics, bioinformatics, computational biology, connecting cognitive models with brain function.

The program is designed primarily for students possessing a B.S. or M.S. degree in mathematics, physics or related technical discipline. The three focus areas are interdisciplinary by nature. They will provide students the opportunity to develop high-demand quantitative skills that are specialized in several applied scientific areas, while ensuring that they are well grounded in more traditional areas of mathematics, physics, chemistry, earth science, biology, and cognitive science. Integrating these areas, the program will emphasize detailed analyses of the mechanisms underlying important scientific phenomena.

The interdisciplinary/multidisciplinary nature of high-impact scientific research and development is widely recognized, as is the need to connect basic and applied research. In commenting on its importance, a working definition of interdisciplinary research has been set forth in a National Academies' report: "Interdisciplinary research is a mode of research by teams or individuals that integrates information, data, techniques, tools, perspectives, concepts, and/or theories from two or more disciplines or bodies of specialized knowledge to advance fundamental understanding or to solve problems whose solutions are beyond the scope of a single discipline or area of research practice." (From *Facilitating Interdisciplinary Research*, report of Committee on Facilitating Interdisciplinary Research, Committee on Science, Engineering, and Public Policy, National Academies, Washington, 2004.) The proposed program will encourage students to explore connections between scientific disciplines, as well as connections between basic and applied research.

The proposed Ph.D. program is timely and will provide Wright State with the opportunity to become competitive at a national level for research students and faculty. While WPAFB will likely remain the largest local employer and a technological leader in the Dayton area, it is restricted by its inherent Department of Defense Mission from exploring many of the emerging technological fields (e.g., advanced energy technology, biomedicine, and bioengineering) that universities are aggressively pursuing. By emphasizing an interdisciplinary approach, Wright State expects to attract world-class faculty and to graduate top-notch researchers with the foundation and skills in the physical sciences and mathematics that will enable them to advance their own and related technical fields.

2. Proposed Curriculum

With the accelerating rate of technological development evident today, even highly trained scientists entering business and industry cannot predict which of their skill sets will be needed during their careers. It is highly desirable to equip students with a broad exposure to current scientific problems and provide them with the tools necessary to be successful analysts and researchers, including the ability to adapt and update their knowledge and technical skills in the workplace. This requires a strong foundation in applied mathematics and physics, a foundation that was fundamental to U.S. scientists and engineers in the 1950's through the 1980's, but began eroding in the 1990's during the ".com bubble." The proposed Ph.D. program will restore this foundation starting with the creation of a one-year course in "mathematical methods of science" similar to the "math methods" courses taken decades ago by scientists and engineers now on the verge of retirement.

As described above, students accepted into the program must have earned a B.S. or M.S. degree in mathematics, physics or a related technical discipline, including coursework in differential equations and general physics. As Ph.D. candidates, all students will receive interdisciplinary training through coursework and research. During Years I and II, students will take 6 core courses designed to illustrate the interdependence of traditional academic disciplines and provide a basic foundation in the techniques of modern scientific discovery. Students will choose at least 2 courses from each of the following 3 core groups (sample courses are listed for each group). I. Mathematics: mathematical methods of science, modeling under uncertainty, scientific computing, optimization, inverse problems, numerical solution of differential equations. II. Physics: electromagnetic fields and waves analysis, quantum and statistical mechanics, photonics, solid-state devices. III. General Sciences (introductory level classes): cell biology, biochemistry and molecular biology, organic and physical chemistry, environmental chemistry, earth and environmental science, remote sensing, geophysics, human factors and design, cognition and learning. Core course choices will depend on students' interest and preparation. Well-prepared students may choose from more advanced courses including analysis, algebra, numerical analysis, theory of statistics, mechanics, complexity theory, fundamentals of biological computation and modeling, ultrafast optics, molecular spectra and structure, terahertz physics, solid state physics, advanced electromagnetics and many body physics. As an example of core coursework, a beginning student might take a 2 semester sequence in mathematical methods of science, a 2 semester sequence in electromagnetism, and survey courses in biosciences and statistical methods for practicing scientists. (See Appendix A for proposed student Program of Study.)

As soon as possible, students will select a thesis advisor and a dissertation topic motivated by a physical problem. A dissertation committee will be formed consisting of program faculty from at least two CoSM departments, including the thesis advisor, a WSU faculty member external to CoSM, and an appropriately chosen scientist external to WSU. During Year 2 of the program, students will complete advanced coursework in their chosen area of specialization and prepare for a qualifying examination to be administered by the dissertation committee at the end of Year 2. Although considerable specialized coursework presently exists, new courses will be developed as needed. Upon successfully completing the qualifying examination, Ph.D. candidates will concentrate on dissertation research.

3. Program Administration

The program will be administered through CoSM. A Program Director reporting to the CoSM Dean will oversee program operations. An Executive Committee will oversee program structure and requirements, a Curriculum Committee will oversee course content and give advice on qualifying examinations, and an Admissions Committee will oversee the acceptance of qualified students into the program. Applicants for the program should possess a B.S.

or M.S. degree in a technical discipline. Previous research experience is desirable. The primary disciplines from which students will be accepted will be mathematics, physics, statistics, chemistry, engineering, biological sciences, geological sciences, cognitive sciences, and artificial intelligence. An External Advisory Board will be assembled. It will be comprised of representatives from organizations external to WSU with vested interests in the program and will provide advice and practical direction to the Executive Committee.

4. Program Need

Ph.D.-trained individuals are essential for the nation's economic vitality. The state of Ohio is committed to encouraging high tech industries to flourish. Federal and state governments envisage a continuing transformation to an information-based society in which highly skilled jobs will abound. The Dayton area, already a regional hub for technology, is ideally positioned for continued growth in both pure and applied research. WPAFB is the largest regional high tech employer and the area surrounding the base hosts a variety of high tech firms that provide the USAF with technological expertise. Graduates of the proposed Ph.D. program should readily find employment in the Dayton region and throughout the state, as well as being in demand nationally or globally. Ohio does not currently have a similar interdisciplinary doctoral program in applied science and mathematics.

Research conducted at WPAFB represents a rich and varied source of research problems and support for students and faculty. Expressions of support obtained from AFRL/WAFB, AFIT, and local industry indicate enthusiastic support for the objective of training skilled professionals for the high technology jobs in the Dayton region.

Sophisticated technologies will need to be developed in order to confront the great social, economic and environmental challenges of our day: energy production, global warming, medical demands of an aging population, crumbling infrastructure, food security, defense, transportation, and internet bandwidth adequacy and security. Science and technology must play prominent roles in solutions to these daunting problems. The nation will require a highly trained and broadly knowledgeable workforce to realize success. The Bureau of Labor Statistics has projected that nationally, employment in the mathematical, biological, and physical sciences will likely grow 15-20% between 2008 and 2018. Additionally, those with M.S. and Ph.D. degrees should enjoy increasingly better employment opportunities. The Dayton region will play a prominent role in addressing the nation's complex problems and technology needs. Graduates of the proposed interdisciplinary Ph.D. program will possess the skills needed to address these vital economic, defense and social concerns.

5. Prospective Enrollment

Initially a maximum of 5 Ph.D. students will be accepted each year. Given that students will require approximately 5 years to graduate and some loss of students is inevitable, there should be approximately 25 to 30 students in the program by year 6. Future growth in program faculty with funding may increase program size. Within CoSM, several M.S. programs (i.e., Applied Mathematics, Biostatistics, Earth and Environmental Sciences, Biological Sciences, and Physics) will serve as natural conduits for student recruitment.

6. Access and retention of women, ethnic minorities and students with disabilities.

Women, ethnic minorities and people with disabilities remain significantly underrepresented in the STEM (Science, Technology, Engineering, and Mathematics) disciplines. Within CoSM and WSU, several successful programs have been directed toward attracting traditionally underrepresented groups. WSU has programs aimed at providing research experience for high school students and undergraduates from ethnic minorities. Recent U.S. Department of Education and NSF grant funding has supported minority graduate students and the development of a laboratory curriculum for students with disabilities. WSU has a demonstrated commitment to multiculturalism through designated centers and programming. It enjoys a national reputation for disability services. The campus was constructed to be architecturally barrier free and has an Office of Disability Services that provides service to over 500 students with disabilities. WSU is a founding member of The LEADER Consortium, funded in part by the National Science Foundation ADVANCE Program. This consortium is a partnership of four diverse institutions of higher education in the Dayton area: the Air Force Institute of Technology, Central State University, University of Dayton, and Wright State University. Launched publicly in November 2008, the LEADER Consortium is a member of the fourth cohort of ADVANCE award recipients and is the first of its kind in the ADVANCE Program. Together, these partners aim to identify, research, and implement best practices to increase the recruitment, advancement, and retention of tenure-track women faculty in STEM.

7. Program Faculty and Facilities

Program Faculty Expertise

Program faculty will be drawn primarily from two CoSM departments, the Department of Mathematics and Statistics, and the Department of Physics.

Faculty in the Department of Mathematics and Statistics engage in basic and applied research, and possess expertise in a wide variety of applied science areas. Applied mathematics research areas include optimal control theory, shape optimization, inverse problems, electromagnetic scattering and tomography, the control of fluid flows in aeronautics, stability analysis for dynamic systems, structural and control optimization, numerical linear algebra, and the numerical solution of partial differential equations. Classically oriented mathematics research areas include partial differential equations, discrete mathematics and combinatorics, operator theory, industrial mathematics, harmonic analysis, coding theory, operator algebras, fractals, graph theory, Fourier analysis, and probability theory including stochastic processes. Applied statistics research areas include categorical data analysis, causal inference, clinical trials, mixture models, the design and analysis of experiments, functional and longitudinal data analysis, hierarchical Bayesian models, multiple comparisons, multivariate statistics, nonparametric statistics, quality control, sampling design, survival analysis and efficacy studies. Faculty have engaged in interdisciplinary projects with CoSM faculty in hydrology using partial differential equations to model ground water diffusion, in tomographic imaging of subsurface geology, and NMR imaging using optimal control theory. Faculty have held summer appointments at WPAFB and NASA Glenn Research Center.

Faculty in the Department of Physics engage in basic and applied research in a wide range of areas. The Endowed Chair in Physics "THz Sensor Physics," held by Elliot Brown, is endowed by both Ohio Board of Regents and WSU funds and provides a critical component of the foundation for the proposed program. The physics faculty may be divided into the following three principle research clusters:

The Terahertz Collaborative Research Cluster explores basic THz phenomenology for sensing and imaging applications including the study of the vibrational resonances of biomolecules in breath analysis (medical diagnostics), environmental monitoring, and biometric signatures. Electromagnetic propagation studies include multi-scale scattering, inverse problems, plasmonic waveguides, and transient signatures associated with sensing and imaging applications. Materials studies include ultrafast photoconductive investigations of metal-semiconductor nanocomposites and the study of the THz optical properties of novel materials. Computational research includes multi-physics and full-wave electromagnetic studies of components for THz system development, such as for plasmonic devices. Technologies available include electronic frequency multiplication systems, femtosecond laser based time-domain-spectroscopy and imaging, difference frequency generation system, imaging gantries, heterodyne radar systems, and test instrumentation.

The Materials Science Research Cluster includes several faculty involved in novel materials research, including chemical synthesis and growth (pulsed laser deposition and sputtering) as well as the characterization of the electrical, microfluidic, optical, magnetic and thermal properties of the materials. Device physics studies include transport processes and nano-enhanced functional characteristics of materials such as mulitferroics, carbon nanotubes and peptide nanowires, graphene, nitride semiconductors, zinc oxide, photorefractive materials, and DNA biopolymers. Instrumentation for the study of these materials include UV-VIS-IR-THz-microwave spectrometers, atomic force microscopes, evanescent microwave microscopy, particle accelerators (electron and proton Van de Graaf and an ion implanter) for the study of defects, Hall effect measurement system, and a deep level transient spectroscopy system.

The Physical Modeling and Computational Research Cluster includes broad topics such as flow transport processes in random systems, percolation theory applied to geophysical processes, NMR applications using optical control theory, space physics and aeronomy research, and modeling of planetary atmospheres. Other areas of ongoing research activity include nonlinear systems analysis, scaling, self-similar criticality, complexity in geophysics, modeling of seismic activity, bioinformatics, and modeling of biochemical processes.

Extramural Funding
Program faculty are successful in obtaining extramural funding (NSF, AFOSR, WPAFB, NIH, NSA). In calendar year 2010 in excess of $3,000,000 were secured.

Existing Facilities

(a) THz Sensors Group: **http://www.cecs.wright.edu/research/thz/**

(b) Nanoscience: This research laboratory includes a variety of nano-profilometric and diagnostic tools including evanescent microwave microscopy and atomic force microscopy.

(c) THz Spectroscopy and Imaging: Research instrumentation permits investigation of vibrational and rotational physics of vapor-phase molecules, and THz imaging of the human exterior and other solid-objects.

(d) AFRL Collaborations: Center for Innovative Radar Engineering (CIRE), an AFRL Program in the Sensors directorate. Optoelectronics Technology Branch of AFRL Sensors Directorate supported by the DoD SMART Program.

(e) Computing cluster: DURIP Award to the THz Sensors Group, 252-core, >2 TB RAM Cluster; 20 compute nodes + 1 head node. Equipped with Gaussian-09, a state-of-the-art tool for quantum chemistry computations, HFSS, a high frequency structure simulator, and a state-of-the-art finite-element tool for solving Maxwell's equations.

Strategic Partnerships

To augment existing WSU resources, several research facilities in the Dayton area have been approached about participation in the proposed Ph.D. Program through collaboration and resource sharing. These include:

(a) AFRL (Sensors Directorate). AFRL is poised to participate in research of common interest, such as advanced electromagnetic propagation and sensing. Three WSU Physics professors are currently actively engaged in AFRL projects.

(b) AFRL (Materials Directorate). The Materials Directorate has a long history and vested interest in WSU collaborations, especially in materials-oriented physics.

(c) UES, Inc. One of the oldest and most successful high-tech companies in the Dayton area, UES has long served the technical needs of WPAFB in areas ranging from aeronautics to advanced ceramic materials. Recently, UES has begun a strategic collaboration with the THz sensors group toward the first THz characterization of CMC ceramic materials and high-energy ion-implantation to create advanced THz metal-semiconductor nanocomposites.

(d) Neuroscience, Dermatology and Pathology (WSU). One of the more interesting questions in biophysics is the effect of RF-to-THz radiation on soft tissue, both healthy and diseased. The Boonshoft School of Medicine has experts in these areas that can provide tissue samples and pathology support.

(e) Biochemistry and Molecular Biology (WSU). Current expertise includes wound healing, biological sensors, magnetic resonance analysis of intermediary metabolism under normal and stress conditions, and DNA structure.

8. Additional Needs for Faculty and Facilities

The CoSM currently hosts Ph.D. programs in Biomedical Sciences, Environmental Science and Human Factors and Industrial/Organizational Psychology. Active faculty in CoSM provide a core group of Ph.D. program faculty with necessary expertise to recruit and advise Ph.D. students. Additional program faculty will be hired as retiring CoSM faculty are replaced. New positions will be expected to fill demonstrated areas of need. The existence of the proposed Ph.D. program will play a vital role in hiring new faculty, as current faculty in Mathematics and Statistics and Physics do not have access to Ph.D. students. Start-up costs for new hires will be competitive to attract top-flight researchers. Additional space needs will be partially addressed with the new NEC (Neuroscience and Engineering Collaboration) building.

9. Projected Additional Costs and Evidence of Institutional Commitment

It is anticipated by both the Department of Mathematics and Statistics, and the Department of Physics, that there will be considerable faculty turnover in the next 5 years due to retirements. These departments and CoSM are committed to directing new department hires into faculty recruitments in support of the proposed Ph.D. program. The College leadership is promoting cluster-hiring strategies within the college, demonstrating its commitment to support interdisciplinary research, an essential ingredient of the Ph.D. program. Students in the program will be supported by a combination of Graduate Teaching Assistantships (GTA), and Graduate Research Assistantships (GRA) funded by faculty advisors' extramural research contracts. It is also anticipated that a limited number of Fellowships will be awarded through Research Challenge funds. Approximately 6 existing GTA positions in the primary program departments will be directed to Ph.D. students. To maintain a program size of 25 students, 7-8 new GTA positions will be needed by year 5. The CoSM is committed to securing these GTA positions as the program grows.

Appendix A: Program of Study

Program of Study for Ph.D. Degree in

Interdisciplinary Applied Science and Mathematics

Year 1: Interdisciplinary Training

- During Year 1, students will take approximately 6 courses designed to illustrate the interdependence of traditional academic disciplines and provide a basic foundation in the techniques of modern scientific discovery. Students will take a yearlong course sequence, *Introduction to Applied* Science (Introduction to current research topics in mathematics and the sciences; introduction to modern research tools and analytical techniques; matlab programming.), and at least 4 courses from the 3 IASM Core groups (Focus groups).

- A substantial part of Year 1 is devoted to preparing students to conduct their thesis research and be able to communicate their results in both oral and written formats. Accordingly, students will take the yearlong course *IASM Introduction to Research* (introduction to research skills and methodologies; introduction to program research topics and faculty). Students will also receive guidance in selecting a research advisor at this time.

- The first year course schedule would typically appear as follows:
  - *Introduction to Applied Sciences I, II* (4 hours each)
  - *IASM Core Classes* (12 hours total) (4 IASM Core courses, 3 hours each)
  - *IASM Introduction to Research I, II* (2 hours each)

Year 2: Foundation Development

- In Year 2, students will continue to develop a foundation in interdisciplinary science and also select coursework appropriate for their thesis research.

- In Year 2, students will continue to prepare to conduct their thesis research. This is facilitated by students taking the *IASM Graduate Seminar* (literature searches; presentation of research articles; research talks by program faculty and external speakers) during their 2nd year.

- During Year 2, students will begin to transition their focus from course work to research and begin preparing for their qualifying examinations. It is expected that by the end of Year 2, students will have selected their dissertation committee and completed their qualifying exams.

- The 2nd year course schedule would typically appear as follows:
  - *IASM Core Classes* (6 hours total) (2 IASM Core courses, 3 hours each)
  - *IASM Graduate Seminar I, II* (2 hours each)
  - *Research Hours/Independent Study/Optional Advanced Coursework*

Years 3, 4 and 5: Thesis-related Research

- Write dissertation proposal and obtain dissertation committee approval
- Dissertation research
- Hold two (2) committee meetings yearly

Year 5

- Obtain permission to write dissertation
- Write, present and defend dissertation
- Apply for graduation (Graduate Studies Office) and graduate

Planned IASM Core Curriculum Groups & Selected Courses

I. Mathematics

Mathematical Methods of Science (new sequence to be developed)
MTH 6060 - Mathematical Modeling
MTH 6070 - Optimization Techniques
MTH 6140 - Mathematical Software
MTH 6150 - Scientific Computation
MTH 6160 - Matrix Computations
MTH 6550 - Advanced Linear Algebra
MTH 6810, 6820 - Applied Mathematics I, II
MTH 7160, 7160 - Numerical Analysis I, II
MTH 7370 - Complex Analysis
MTH 7160,7170 – Real Analysis I, II
MTH 7510, 7520 – Modern Algebra
STT 6610,6620 – Theory of Statistics I, II
STT 6640 – Computational Statistics
STT 6660,6670 – Statistical Methods I, II
STT 7020 – Stochastic Processes
STT 7620 – Advanced Topics in Linear Models
STT 7670 – Applied Regression Analysis

II. Physics

PHY 6000 - Physics of Semiconductor Materials and Devices
PHY 6270 - Physics of Remote Sensing
PHY 6320 – Lasers
PHY 6400 - Nanoscience and Nanotechnology
PHY 6430 - Analysis and Prediction of Complex Natural and Human Systems
PHY 6630 - Introduction to Solid State Physics
PHY 6730 - Mathematical Physics
PHY 6800 - Classical Mechanics
PHY 6810, 6820 - Electromagnetic Theory I, II
PHY 6830 - Statistical Mechanics
PHY 7100, 7110 - Quantum Mechanics I, II
PHY 7200 - Many-Body Physics
PHY 7210 - Complexity in Environmental Systems
PHY 7300 - Topics in solid state physics – structure
PHY 7310 - Topics in solid state physics – Electromagnetics
PHY 7530 - Topics in Ultrafast Optics
PHY 7550 - Topics in Terahertz Physics
PHY 8250 - Fundamentals of Biological Computation & Modeling

III. General Sciences

BMB 7500 - Molecular Biochemistry I
BMB 7520 - Molecular Biochemistry II
BMB 7530 - Molecular Signaling - Molecular Cell Biology
BMB 7650 - Computational Tools and Strategies in Biomed Sciences
BIO 6460 - Advanced Cell Biology
BIO 6810 - Algorithms for Bioinformatics
BIO 7300 - Cell Biology
CHM 6020 - Advanced Environmental Chemistry and Analysis
CHM 6170 - Applied Chemical Spectroscopy
CHM 6650 - Physical Polymer Chemistry
CHM 6680 - Experimental Nanomaterials and Nanoscience
CHM 7500 - Introduction to Quantum Chemistry
EES 6220 - Introduction to Geophysics
EES 6250 - Climate Change
EES 6290 - Remote Sensing of Earth

EES 6370 - Seismic Reflection Digital Imaging and Processing
EES 6430 - Analysis and Prediction of Complex Natural and Human Systems
EES 6610 - Near-Surface Geophysics
EES 7100 - Complexity in Environmental Systems
EES 7490 - Modeling Subsurface Fluid Flow
ES 7120 - Environmental Biology: Genes, Organisms, and Ecosystems

IASM Proposed Curriculum

Core Courses	Credit Hrs.
Introduction to Applied Sciences I, II	8
IASM Core I – Mathematics (2 courses)	6
IASM Core II – Physics (2 courses)	6
IASM Core III – General Sciences (2 courses)	6
IASM Introduction to Research (2 semesters)	4
IASM Graduate Seminar (2 semesters)	4
Sub Total	**34**
Advanced Electives	(Minimum) 9
Course Total	**43**
Independent Topics & Research	Variable
Dissertation Research	(Minimum) 30
Total	**90**

Appendix B: Ph.D. Program Faculty

Mathematics and Statistics Department
Evans, Tony
Fang, Weifu
Huang, Chaocheng
Huang, Qingbo
Chen, Yuqing
Li, Qun
Li, Yi
Li, Gngxin
Miller, David
Seoh, Munsup
Slilaty, Dan
Wang, Weizhen
Tarpey, Thad
Turyn, Larry
New hire(s) 2013?
New hire(s) 2014?

Physics Department
Brown, Elliott
Deibel, Jason
Farlow, Gary
Foy, Brent
Hunt, Allen
Kozlowski, Gregory
Medvedev , Ivan
Petkie, Douglas
Skinner, Thomas
Tebbens, Sarah
New hire(s) 2013?
New hire(s) 2014?

Other COSM Departments
Bahn, Volker (Bio)
Barton, Chris (EES)
Flach, John (Psych)
Houpt, Joseph (Psych)
Juvina, Ion (Psych)
Hartzler, Lynn (Bio)
Krane, Dan (Bio)
Ritzi, Robert (EES)
Stireman, John (Bio)