**TITLE: BS in Integrated Science - College of Science**

**GOALS and JUSTIFICATION**:

The primary goal of the Integrated Science Program (ISP) is to provide talented and promising undergraduates with an opportunity to pursue studies that go beyond both the traditional major in a single field of science and traditional double majors. In contrast to a double major that provides separate knowledge in two disciplines, the proposed Integrated Science Program would augment a classic deep technical education in more than one discipline with integrated skills to enable the student to conduct interdisciplinary research across multiple disciplines. Unlike a double major, **the ISP will provide a goal-oriented education in the fusion of two or more disciplines**, culminating in a senior thesis (their “odyssey”) that demonstrates this fusion.

Great advances in the science and mathematics disciplines occur in one of two fundamental ways: (1) through focused, discipline-based research, or (2) through collaborative problem solving by scientists from complementary disciplines tackling a problem of common interest that could not be solved within a single discipline. University students are usually educated in a specific discipline. This education prepares a student to address problems using tools and approaches drawn from that discipline, assures technical depth, and produces graduates whose credentials are recognized worldwide. However, the importance of interdisciplinary collaboration is well documented. Over the past half-century, we have seen the emergence of Nobel-prize winning breakthroughs that could only have been accomplished through the interdisciplinary work of the researchers (e.g., Watson – biology; Crick – physics; and Wilkins – physics – cracked the structure of DNA1 through their determined collaborative work, along with Rosalind Franklin, chemist and crystallographer2). The National Science Foundation (NSF) has long recognized the importance of interdisciplinary research through the support of research on problems that transcend the scope of a single discipline. It has dedicated a division specifically for the support of interdisciplinary research3. The National Institutes of Health (NIH) has similarly aggressively supported interdisciplinary research in medically related fields4.

The boundaries between academic disciplines are blurring. Previously unconnected research disciplines are now starting to overlap and merge, with physicists, chemists, biologists, engineers, medical researchers, computer scientists and mathematicians pooling their expertise to attack common problems. In some cases, these blurred boundaries give rise to a separate, recognized field of study (e.g., Imaging Science, Neuroscience, Environmental Science, etc.). Many new interdisciplinary fields such as bioinformatics, environmental sustainability, packaging science, artificial intelligence, robotics and others are constantly emerging. Research in these new fields and the pace of advances are facilitated by rapidly evolving technologies that enable instantaneous, worldwide collaborations and immediate access to shared global scientific data.

Desired learning outcomes common to all students in the ISP major:

* Technical working knowledge of a platform level of the science and mathematics disciplines
* In-depth command of at least two existing Science and Mathematics disciplines, one or both of which lies within the College of Science
* Knowledge of Project Management
* Knowledge of the entrepreneurship process
* Excellent technical communication skills
* Evidence of original work fusing two or more Science and Mathematics disciplines, formally proposed before the second year, and presented as a team-based senior thesis, the *Keystone Project*.

**DESCRIPTION OF THE PROGRAM**:

The ISP is an innovative curricular program within RIT’s College of Science that offers students an opportunity to complete a technical course of study related to a scientific inquiry, or odyssey, that requires integration of more than one discipline and is not currently offered by any other program at RIT. The ISP is designed to broaden and enrich the study of the STEM disciplines while developing a rigorous depth of knowledge in the selected integrated fields. It is open to a select group of students, both incoming and upper-class students, who possess exceptional scientific and mathematical aptitude, are strongly motivated to succeed academically, and are especially eager to study an integration of more than one discipline of science and mathematics within the context of a liberal arts and sciences education.

Candidates can be admitted into the program by preparing a formal application for admission to the ISP. The application will include a study plan for the balance of their undergraduate education, listing the two, or more, disciplines to be fused, a general integrated science topic (their personal odyssey), and the names of one willing faculty mentor in each of the disciplines. Students eligible for admission to the ISP belong to one of two groups of students:

* Those admitted to or enrolled in the COS Honors program may submit an ISP proposal
* Those students in years one through three who have achieved Dean’s List at least once during the most recent 2 semesters, have a GPA of at least 3.5, and have no grade of I, W, F or D

Students admitted to the ISP:

* Will maintain a minimum cumulative GPA of 3.3
  + Failure to do so will trigger a review of the student’s suitability for the ISP major and a course of action will be decided by the faculty mentors and the ISP Director in consultation with the student
* Will have completed (or be on course to complete) two College of Science foundation of courses in two of the following disciplines: Biology, Chemistry, Physics or Imaging Science; and a foundation sequence in Mathematics, all from a predetermined selection of foundation courses
* Will preferably have completed two consecutive semesters of a COS Science Exploration Program (SEP) before the start of their third year. The SEP will offer insight and hands on laboratory experience in topics covering all of the STEM disciplines, thereby teaching research protocols as well as project management and the dynamics of interdisciplinary teams. The SEP will also sow the seeds of inquiry needed to begin to define a long-term integrated research project.
* Will have submitted, by the end of the Spring Semester of their second year of study, an original written proposal for an Integrated Science Senior Thesis (keystone project) that will address a clearly articulated problem (odyssey) or educational goal that sufficiently integrates the two, or more, approved disciplines
  + A program admission decision will be made within 2 weeks of submission
* Will form teams for their *Odyssey* during the course of their Science Exploration Program in the first and second years. The Odyssey will be defined by an overarching challenge, or question, that requires an integration of multiple disciplines to tackle. The research necessary to answer the question posed in the Odyssey will serve as the team’s *Keystone Project* that will be presented in their senior thesis. The Odyssey will encompass at least three years of the students’ coursework and research program. (Teams will typically be made up of from 1-3 ISP students plus collaborators from other programs across RIT.)
* Will be admitted upon the approval of the ISP committee (consisting of the heads of the involved schools and the ISP Director). Students accepted into the ISP will be assigned an advisor in each of the main disciplines comprising their interdisciplinary field, and an academic advisor in the ISP. They will complete the University’s General Education requirements while pursuing their degree. In addition to the courses required by the student’s selected minors, if any, and those required by General Education, the ISP will offer special topics courses selected from offerings across the University. These special topics may cover, for example, entrepreneurship, the use of social media, marketing and other topics as ISP student interests dictate.

**FIT WITH RIT’S MISSION AND STRATEGIC DIRECTIONS:**

The Integrated Science Program will complement RIT’s Vision, Mission and Strategic Direction through the implementation of an academic program that enables students, with the direct participation of faculty, to define a personal, rigorous course of study that will span more than one existing science and mathematics discipline. By its very nature, the Integrated Science Program will offer exciting new possibilities to existing and potential students and provide stimulating and collaborative experiences as they complete their Keystone Project (senior thesis) in the integrated area they have selected through definition of an overarching question that defines their Odyssey. The Program will develop and deliver curricula and advance scholarship and research related to the integrated scientific fields selected and created by the students in the program.

The Integrated Science Program directly addresses RIT’s stated Guiding Principle: “*Interdisciplinary academic programs will be encouraged*”. Moreover, the ISP enables RIT, with minimal risk and investment, to fulfill its mission to *“rigorously pursue new and emerging career areas”* and in its capacity to *“develop and deliver curricula and advance scholarship and research relevant to emerging technologies”5.*

**SYNERGY WITH OTHER PROGRAMS**:

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The ISP will work with the two, or more, disciplines involved to create a customized educational plan for each student, such that graduates will have:

* Technical working knowledge of a platform/foundational level of at least ANY TWO of the core Science and Mathematics disciplines
  + Biology with laboratory
  + Chemistry with laboratory
  + Physics with laboratory
  + Imaging Science

PLUS

* + Mathematics
* In-depth command of at least one advanced discipline
  + Four second-year level courses in a discipline sequence
* Interdisciplinary Project Management
* Knowledge of the entrepreneurship process
  + Completion of Entrepreneurship for Scientists or equivalent
* Technical communication skills
  + Two courses in English, one of which must be Writing Seminar
  + Oral presentations at a weekly ISP seminar

**ADMINISTRATIVE STRUCTURE**

The ISP will be housed within the College of Science. The main governance will be a Program Director who will be selected from the faculty engaged in the program. The Dean of the College of Science, in consultation with the heads of the existing COS academic units, will make the final selection for the directorship of the program. The ISP Director will report directly to the Dean and will work with the relevant academic discipline heads (or their appointees) to create an integrated science curriculum for each student admitted into the program, using electives from each of the related discipline majors to create an achievable technical education that spans the selected disciplines. The Director will also oversee the budget of the program, student recruitment, and delivery of the curriculum; will advocate for the program; will work with individually selected advising committees to monitor students’ progress; will allocate teaching responsibilities; and will work with the department heads and school heads of the constituent faculty to provide feedback as to the contributions of their faculty to the program. The Director will track the effectiveness and enrollment of the program and provide an annual report to the Dean of the College of Science.

**ENROLLMENT MANAGEMENT EXPECTATIONS AND SUSTAINMENT**

Integrated Science Programs have been implemented and are operating successfully at many leading universities, including Princeton6, the University of Pennsylvania7 (a Master’s degree program in Integrated Science and Education), Columbia University8 (research), the University of Arizona9, McMaster10 (an honors program) and more. A new, and already highly ranked, university has been founded based on this sort of program across a range of disciplines, including science.11 This suggests that a growing number of students are seeking degrees that span more than one conventional discipline. The proposed ISP would allow RIT to step forward and announce the availability of an attractive new educational program that combines our technical depth and breadth while giving the gifted student the privilege of proposing a specific combination of disciplines that are of particular interest to them. This ability to fuse two disciplines of the student’s choosing, combined with RIT’s technical reputation and academic rigor, is expected to draw additional highly-qualified students to RIT, increase enrollment and create a new graduating student population that will have superior training as they compete for subsequent employment. Academic excellence will be maintained in two ways: (1) through the personal mentoring of each student by faculty appointed from the selected disciplines, and (2) through the collective guidance (by the ISP office) of the student towards the goal of a team-based senior project/thesis that demonstrates the fusion of those disciplines. The additional educational enrichment provided by the ISP program through courses in project management, entrepreneurship, self-organization and teamwork is also expected to create increased enrollment in the program. Using the ISP as a framework, RIT can begin marketing the ISP quickly to new incoming classes of students, and establish a presence in this growing educational segment. The longevity of the above-cited programs speaks directly to the sustainability of necessary enrollment in the ISP.

**IMPACT ON RESOURCES**

The proposed ISP carries the following impacts:

* RIT resources (faculty, staff and space)
  + The Program uses existing majors, combined within a student’s educational plan, to produce a technical education in an interdisciplinary science and mathematics field
  + The Program would require the appointment of a fulltime Director, a part time staff support person, part time support from an academic advisor, associated office space, and a dedicated wet lab capable of seating at least 20 students (500 sq ft)
  + Faculty support in the participating departments
  + The ISP would require an initial operating budget to cover:
    - Special equipment and supplies,
    - Laboratory equipment not currently available on campus,
    - An annual student dinner or similar recognition event
    - Development and distribution of marketing material to advertise the program
  + The ISP would require resources for teaching courses in Project Management, Entrepreneurship, and Interdisciplinary Teamwork to the extent that these courses are unavailable elsewhere on campus
* A likely increase in RIT enrollment due to an expanded educational offering
* The immediate expansion of RIT’s educational offerings into new areas without sacrificing technical excellence

**CONCLUSION:**

As a result of the rapid evolutionary pace at which fields appear, it is nearly impossible to predict those areas that will demand the long term investment of educational resources by universities. Some of these new fields will blossom, and others will wither. It is neither practical nor prudent for a university to invest faculty, staff and building resources early in an interdisciplinary program whose long-term viability has not been demonstrated. In order to remain competitive in both research and academics, RIT must offer educational paths for students to design, with the guidance of faculty, a rigorous integrated science program of study in the fusion of existing science and mathematics disciplines.

This concept paper proposes the creation of the Integrated Sciences Program (ISP) within the College of Science at RIT. It is based on two guiding principles: (1) that many of the most important future scientific advances, although based in conventional disciplines, will span two or more disciplines, and (2) a rigorous education across those disciplines will increase the likelihood of a student’s future success. This program is an innovative curricular program that offers students an opportunity to complete a technical course of study in a field that spans more than one discipline and is not currently offered by any other program at RIT. The ISP is designed to broaden and enrich the study of the STEM disciplines while developing a rigorous depth of knowledge in the selected interdisciplinary fields. It will be open to a select group of students who possess exceptional scientific and mathematical aptitude, who are strongly motivated to succeed academically, and who are especially eager to study a fusion of more than one discipline of science or mathematics within the context of a liberal arts and sciences education.

The ISP will include training in project management, critical thinking, problem solving, teamwork, entrepreneurship, and scientific writing. It will be supported by a broad, solid educational foundation in Science and Mathematics courses within the College of Science and an in-depth education in the disciplines required for the integrated field. While educating students at the front edge of science, the proposed ISP program is resistant to obsolescence.

**References:**

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