|  |  |
| --- | --- |
|  |  |
| S:\Communications\Logos and photos\SDBORLogos\final_sdbor_webreadyBW_trans.gif | **SOUTH DAKOTA BOARD OF REGENTS**  ACADEMIC AFFAIRS FORMS |
| Substantive Program Modification Form |
|  |  |

Use this form to request minor changes in existing programs (majors, minors, certificates, or specializations).

|  |  |
| --- | --- |
| **UNIVERSITY:** | DSU |
| **CURRENT PROGRAM TITLE:** | **B.S. Physical Science** |
| **CIP CODE:** | **40.0101** |
| **UNIVERSITY DEPARTMENT:** |  |
| **UNIVERSITY DIVISION:** | **College of Arts and Sciences** |

**University Approval**

*To the Board of Regents and the Executive Director: I certify that I have read this proposal, that I believe it to be accurate, and that it has been evaluated and approved as provided by university policy.*

|  |  |  |
| --- | --- | --- |
| C:\Users\slaughts\AppData\Local\Microsoft\Windows\INetCache\Content.Word\Dr. McKay Signature.jpg |  | 11/7/2018 |
| Vice President of Academic Affairs or  President of the University |  | Date |

|  |
| --- |
|  |

1. **This modification addresses a change in (*place an “X” in the appropriate box*):**

|  |  |  |  |
| --- | --- | --- | --- |
|  | Total credits required within the discipline |  | Total credits of supportive course work |
|  |  |  |  |
|  | Total credits of elective course work |  | Total credits required for program |
|  |  |  |  |
|  | Program name |  | Existing specialization |
|  |  |  |  |
|  | CIP Code |  | Other (explain below) |

1. **Effective date of change: 7/1/2019**
2. **Program Degree Level (*place an “X” in the appropriate box*):**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Associate |  | Bachelor’s |  | Master’s |  | Doctoral |  |

1. **Category (*place an “X” in the appropriate box*):**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Certificate |  | Specialization |  | Minor |  | Major |  |

1. **If a name change is proposed, the change will occur (*place an “X” in the appropriate box*):**

|  |  |
| --- | --- |
|  | On the effective date for all students |

|  |  |
| --- | --- |
|  | On the effective date for students new to the program (enrolled students will graduate from existing program) |
|  |

|  |  |
| --- | --- |
| **Proposed new name:** | **Analytical Science** |
|  | *Reminder: Name changes may require updating related articulation agreements, site approvals, etc.* |

1. **Primary Aspects of the Modification (*add lines or adjust cell size as needed*):**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| *Existing Curriculum* | | | | *Proposed Curriculum (highlight changes)* | | | | | |
| **Pref.** | **Num.** | **Title** | **Cr.**  **Hrs.** |  | **Pref.** | | **Num.** | **Title** | **Cr. Hrs.** |
| **System Wide General Education Requirement\*** | | | 30 |  | **System Wide General Education Requirement\*** | | | | 30 |
|  |
| \*Majors must take CHEM 112, MATH 123, and PHYS 211 as part of the System-wide General Education Requirement | | | |  | \*Majors must take CHEM 112, MATH 123, and PHYS 211 as part of the System-wide General Education Requirement | | | | |
|  |
|  |  |  |  |  |  | |  |  |  |
| **Required Courses** | | | **30-31** |  | **Physical Science Component** | | | | **20** |
| CHEM | 114 | General Chemistry II | 4 |  | CHEM | | 114 | General Chemistry II | 4 |
| ENGL | 379 | Technical Communication | 3 |  | ENGL | | 379 | Technical Communication (or writing intensive) | 3 |
| ~~MATH~~ | ~~125~~ | ~~Calculus II~~ | ~~4~~ |  |  | |  |  |  |
| PHYS | 213 | University Physics II | 4 |  | PHYS | | 213 | University Physics II | 4 |
| **Select one course from the following** | | | 3-4 |  |  | |  |  |  |
|  | | | |  | Majors must select 9 additional credits from the following BIOL, CHEM, or PHYS courses: | | | | **9** |
| MATH | 225 | Calculus III | 4 |  | BIOL | | 335 | Introduction to Bioinformatics\* | 3 |
| MATH | 281 | Introduction to Statistics | 3 |  | BIOL | | 343 | Cell and Molecular Biology\* | 4 |
| MATH | 315 | Linear Algebra (3 credits required) | 3-4 |  | BIOL | | 371 | Genetics\* | 4 |
| MATH | 316 | Discrete Mathematics (3 credits required) | 2-3 |  | \*BIOL courses require completion of BIOL 151 General Biology | | | |  |
| MATH | 318 | Advanced Discrete Mathematics | 3 |  |  | | | |  |
|  |  |  |  |  | CHEM | | 326 | Organic Chemistry I | 3 |
| MATH | 321 | Differential Equations (3 credits required) | 3-4 |  | CHEM | | 326L | Organic Chemistry I Lab | 1 |
| MATH | 413 | Abstract Algebra I | 3 |  | CHEM | | 328 | Organic Chemistry II | 3 |
|  | | | |  | CHEM | | 328L | Organic Chemistry II Lab | 1 |
|  | | | |  | CHEM | | 332 | Analytical Chemistry | 3 |
|  | | | |  | CHEM | | 332L | Analytical Chemistry Lab | 1 |
|  | | | |  | CHEM | | 452 | Inorganic Chemistry | 3 |
| **Select 12 credits from the following (12 Credits** | | | |  | CHEM | | 460 | Biochemistry | 3 |
| CHEM | 492 | Topics (3 credits required) | 1-4 |  | CHEM | | 492 | Topics | 3-4 |
| CHEM | 498 | Undergrad Research/Scholarship (3-6 Credits req. | 1-12 |  |  | |  |  |  |
| PHSI | 492 | Topics (3 credits required) | 1-4 |  | PHYS | | 331 | Introduction to Modern Physics | 3 |
| PHSI | 498 | Undergraduate Research/Scholarship 3-6 credits req | 1-6 |  | PHYS | | 341 | Thermodynamics | 2 |
| PHYS | 492 | Topics (3 credits required) | 1-4 |  | PHYS | | 343 | Statistical Physics | 2 |
|  |  |  |  |  | PHYS | | 361 | Optics | 3-4 |
|  |  |  |  |  | PHYS | | 421 | Electromagnetism | 3 |
|  |  |  |  |  | PHYS | | 424 | Digital Electronics | 3 |
|  |  |  |  |  | PHYS | | 433 | Nuclear and Elementary Particle Physics | 3 |
|  |  |  |  |  | PHYS | | 451 | Classical Mechanics | 3 |
| PHYS | 498 | Undergraduate Research/Scholarship 3-6 credits req | 1-12 |  | PHYS | | 471 | Quantum Mechanics | 3 |
| **Computer Science Component (15 Credits)** | | | |  | PHYS | | 492 | Topics | 3-4 |
| CSC | 105 | Introduction to Computers | 3 |  |  | |  |  |  |
| CSC | 150 | Computer Science I | 3 |  | **Mathematics Component** | | | | **16** |
|  | Choose 9 credits of computer technology courses at the 200 level or above with CSC, SCTC, or MATH prefixes. | | 9 |  | MATH | | 125 | Calculus II | 4 |
|  | MATH | | 201 | Introduction to Discrete Math | 3 |
|  |  |  |  |  | MATH | | 281 | Intro. To Statistics | 3 |
|  | | | |  | OR | |  |  |  |
| **Select seven courses from the following (21-28 Credits)** | | | |  | MATH | | 381 | Introduction to Probability and Statistics |  |
| Some of the courses below are offered by Black Hills State University. | | | |  | Select 6 credits courses from the following | | | | 6 |
|  |  |  |  |  | MATH | | 225 | Calculus III | 3 |
|  |  |  |  |  | MATH | | 231 | Differential Equations | 3 |
|  |  |  |  |  | MATH | | 315 | Linear Algebra | 3 |
|  |  |  |  |  | MATH | | 316 | Discrete Mathematics | 3 |
|  |  |  |  |  | MATH | | 318 | Advanced Discrete Mathematics | 3 |
| CHEM | 326 | Organic Chemistry I | 3 |  | MATH | | 413 | Abstract Algebra I | 3 |
|  |  |  |  |  | MATH | | 418 | Math Modelling | 3 |
|  |  |  |  |  | MATH | | 471 | Numerical Analysis | 3 |
| CHEM | 326L | Organic Chemistry I Lab | 1 |  |  | |  |  |  |
| CHEM | 328 | Organic Chemistry II | 3 |  | **Computer Science Component** | | | | **15** |
| CHEM | 328L | Organic Chemistry II Lab | 1 |  | CSC | | 105 | Introduction to Computers | 3 |
| CHEM | 332 | Analytical Chemistry | 3 |  | CSC | | 150 | Computer Science I | 3 |
| CHEM | 332L | Analytical Chemistry Lab | 1 |  | CSC | | 250 | Computer Science II | 3 |
| CHEM | 452 | Inorganic Chemistry | 3 |  | CSC | | 300 | Data Structures | 3 |
| GEOL | 201 | Physical Geology | 4 |  | CIS | | 372 | Programming for Analytics | 3 |
|  |  |  |  |  |  | |  |  |  |
| GEOL | 310 | Volcanology | 3 |  | **Research/Scholarship Component** | | | | **3** |
|  |  |  |  |  | **Select 3 credits from the following:** | | | |  |
| GEOL | 340 | Mineralogy and Petrology | 3 |  | BIOL | | 498 | Undergrad Research/Scholarship | 3 |
| GEOL | 360 | Geochemistry | 3 |  | CHEM | | 498 | Undergrad Research/Scholarship | 3 |
| GEOL | 370 | Hydrogeology | 3 |  | CIS | | 494 | Internship | 3 |
| PHYS | 331 | Introduction to Modern Physics | 3 |  | CIS | | 498 | Undergrad Research/Scholarship | 3 |
| PHYS | 341 | Thermodynamics (3 credits required) | 2-3 |  | CSC | | 494 | Internship | 3 |
| PHYS | 343 | Statistical Physics (3 credits required) | 2-4 |  | CSC | | 498 | Undergrad Research/Scholarship | 3 |
| PHYS | 361 | Optics (3 credits required) | 3-4 |  | PHYS | | 498 | Undergrad Research/Scholarship | 3 |
| PHYS | 421 | Electromagnetism | 4 |  |  | |  |  |  |
| PHYS | 451 | Classical Mechanics | 4 |  | **Concentration Component** | | | | **15** |
| PHYS | 471 | Quantum Mechanics (3 credits required) | 3-4 |  | Students are required to complete 15 hours of additional 300-400 level coursework in PHYS, CHEM, BIOL, CIS, CSC, or MATH. | | | |  |
| PHYS | 481 | Mathematical Physics | 3 |  |  | |  |  |  |
| Electives | | | 16-24 |  | **Electives Component** | | | | **21** |
|  |  |  |  |  | Three of these electives will have been met upon completion of CHEM 112, MATH 123, and PHYS 211 as part of the system General Education requirements.  Within the electives category, in consultation with their academic advisor(s), students must also take 3 credits of coursework in an appropriate analytical methodologies course relevant to their academic concentration.  Students wanting to prepare for graduate or professional school, or for bachelors-level research-focused career paths, or those simply desiring more intensive independent research experiences, may take an additional 3 credits of Undergraduate Research/Scholarship electives in CHEM, PHYS, BIOL, CIS, CSC, or MATH. These credits may include relevant academic or industry internship experiences as appropriate. | | | |  |
| Total number of hours required for major, minor or specialization | | | 66-74 |  | | Total number of hours required for major, minor or specialization | | | 69 |
| Total number of hours required for degree | | | 120 |  | | Total number of hours required for degree | | | 120 |

1. **Explanation of the Change:**

Dakota State University recognizes that our strength in computation and technology offers a unique opportunity to leverage the development of a similar program in the physical sciences. Given the dizzying pace of evolution in both technologies and research methodologies, graduates with strong skill sets in both data sciences/analytics and the physical and life sciences will be in a unique position to enable advancements across multiple disciplines and workforce sectors. Development of such interdisciplinary skill sets will be a key outcome of this program.

In support of the proposed change, the U.S. National Science Foundation (NSF) has included data-intensive scientific research as a core component of its new*“10 Big Ideas”* funding initiatives for the coming decade (Harnessing the Data Revolution; <https://tinyurl.com/yaagcuyc>). NSF’s commitment to allocating significant funding to data-intensive scientific research proposals is further demonstrated in a recent call for participation in their *“Innovation Labs”* workshops designed to bring together data scientists and physical scientists to forge new collaborative frontiers at the intersections of the data and physical sciences (<https://tinyurl.com/ycwnjyfl>). Such initiatives at the largest basic science funding agency provides ample justification for an Analytical Science degree program at Dakota State.

Additional rationale for the change is provided in a recent report by the U.S. National Academies of Sciences, Engineering, and Medicine (<https://tinyurl.com/y9lxdjtx>). Therein it is recommended that more undergraduate data/analytical science programs be created to keep pace with rapidly growing demand for data scientists with physical science competencies who can work effectively across multiple data- and science-intensive disciplines in all sectors of the U.S. economy. Still more justification is provided in a recent assessment by the United Kingdom’s Engineering and Physical Sciences Research Council (EPSRC) – a collaborative funding partner with the U.S. NSF and Departments of Defense (DOD) and Energy (DOE) – in which they report a critical shortage of analytical science expertise in the UK workforce. Their summary report concluded: *“The critical value of Analytical Sciences lies in its ability to enable scientific advances across multiple disciplines. Analytical sciences research is relevant to a very broad range of disciplines, creating research outputs that will be relevant to multiple areas. The potential for cross-disciplinary relevance should be fostered in ordered to achieve added value from one research idea.”*

Aligned with these compelling national and international recommendations and driven by the demands of swiftly changing global economies, coursework will focus on contemporary computational and analytical methods and their applications to solving problems at the forefront of the chemical, physical, and biological sciences. In pursuit of this aim, substantial analytical statistics and scientific methods development components will be integrated into all courses, ensuring graduates are optimally prepared and maximally competitive for professional and post-graduate study opportunities in all sectors of the global economy informed by the data and physical sciences.

Finally, the proposed modification is logistically simple and cost-effective, requiring minimal curricular changes, no new courses, and no new full-time faculty.