PART I – NEW ACADEMIC PROGRAMS AND PROGRAM CHANGES

COLLEGE OF AGRICULTURE AND NATURAL RESOURCES

1. Request to change the requirements for the Bachelor of Science degree in Animal Science in the Department of Animal Science.

The concentrations in the Bachelor of Science degree in Animal Science are noted on the student’s academic record when the requirements for the degree have been completed.

The concentration in Production Animal Scholars will no longer be available. Students who have not completed the requirements for this concentration by Fall 2021 will have to switch to a different concentration.

a. Under the heading Requirements for the Bachelor of Science Degree in Animal Science replace the entire entry with the following:

The University requirements for bachelor's degrees as described in the Undergraduate Education section of this catalog; 120 credits, including general elective credits, are required for the Bachelor of Science degree in Animal Science.

The University's Tier II writing requirement for the Animal Science major is met by completing one of the following courses: Animal Science 301, 314, or 409. Those courses are referenced in item 3. below.

Students who are enrolled in the Animal Science major leading to the Bachelor of Science degree in the Department of Animal Science may complete an alternative track to Integrative Studies in Biological and Physical Sciences that consists of the following courses: Biological Science 161 and 171, Chemistry 141, and Chemistry 143 or 251. The completion of Biological Science 171 satisfies the laboratory requirement. Biological Science 161 and 171, Chemistry 141, and Chemistry 143 or 251 may be counted toward both the alternative track and the requirements for the major referenced in item 3. below.

The completion of the College of Agriculture and Natural Resources mathematics requirement may also satisfy the University mathematics requirement.

The requirements of the College of Agriculture and Natural Resources for the Bachelor of Science degree.

Certain courses referenced in requirement 3. below may be counted toward College requirements as appropriate.

The following requirements for the major:

<table>
<thead>
<tr>
<th>CREDITS</th>
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</tr>
</thead>
</table>
| a. | All of the following courses (21 credits):
| 101 | Professional Development in Animal Science I |
| 110 | Introductory Animal Agriculture |
| 110L | Introductory Animal Agriculture Laboratory |
| 210 | Introduction to Disciplines in Animal Agriculture |
| 301 | Professional Development in Animal Science II (W) |
| 401 | Issues in Animal Agriculture |
| 161 | Cell and Molecular Biology |
| 171 | Cell and Molecular Biology Laboratory |
| 141 | General Chemistry |
| b. | One of the following courses (3 or 4 credits):
| 200 | Statistical Methods |
| 201 | Statistical Methods |
| 231 | Statistics for Scientists |
| 421 | Statistics I |
| 464 | Statistics for Biologists |
CEM 143 Survey of Organic Chemistry 4
CEM 251 Organic Chemistry I 3
d. Two of the following introductory species management courses (3 credits):
ANS 201 Animal Products 3
ANS 222 Introductory Beef Cattle Management 3
ANS 232 Introductory Dairy Cattle Management 3
ANS 242 Introductory Horse Management 3
ANS 252 Introduction to Management of Avian Species 3
ANS 262 Introductory Sheep Management 3
ANS 272 Introductory Swine Management 3
ANS 282 Companion Animal Biology and Management 3
e. A minimum of 14 credits from the following introductory discipline courses: (14 to 16 credits):
ANS 305 Applied Animal Behavior 3
ANS 305L Applied Animal Behavior Laboratory 1
ANS 307 Animal Reproduction 3
ANS 309 Animal Health and Disease Management 3
ANS 313 Principles of Animal Feeding and Nutrition (W) 4
ANS 314 Genetic Improvement of Domestic Animals 4
ANS 315 Anatomy and Physiology of Farm Animals 4
ANS 407 Food and Animal Toxicology 3
f. One of the following advanced management courses (3 credits):
ANS 422 Advanced Beef Cattle Feedlot Management 3
ANS 432 Advanced Dairy Cattle Management 3
ANS 442 Advanced Horse Management 3
ANS 472 Advanced Swine Management 3
ANS 482 Advanced Companion Animal Management 3
FSC 432 Food Processing: Dairy Foods 3
FSC 433 Food Processing: Muscle Foods 3
g. A minimum of 2 credits in experiential learning (2 to 6 credits):
ANS 300A Advanced Livestock Judging 2
ANS 300C Advanced Dairy Cattle Judging 2
ANS 300D Advanced Horse Judging 2
ANS 300E Animal Welfare Judging 2
ANS 300F Advanced Dairy Farm Evaluation 2
ANS 480 Animal Systems in International Development 3
ANS 492 Undergraduate Research in Animal Science 3
ANS 493 Professional Internship in Animal Science 3
A minimum of 2 credits in a department-approved Education Abroad program. 2 to 6
h. One of the following concentrations (23 to 33 credits):
Animal Industry (20 to 23 credits):
1. Both of the following course (5 credits):
   ANS 201 Animal Products 3
   CSS 110 Computer Applications in Agronomy 2
   ANS 201 may not be used to fulfill requirement 3. d. above.
2. One of the following courses (3 credits):
   ABM 100 Decision-making in the Agri-Food System 3
   ABM 130 Farm Management I 3
3. One of the following advanced management courses (3 credits):
   ANS 422 Advanced Beef Cattle Feedlot Management 3
   ANS 432 Advanced Dairy Cattle Management 3
   ANS 442 Advanced Horse Management 3
   ANS 472 Advanced Swine Management 3
   ANS 482 Advanced Companion Animal Management 3
   FSC 432 Food Processing: Dairy Foods 3
   FSC 433 Food Processing: Muscle Foods 3
   Courses used to fulfill this requirement may not be used to fulfill requirement 3. f. above.
4. A minimum of 9 credits from the following courses (9 to 12 credits):
   ANS 211 Animal and Product Evaluation 3
   ANS 305 Applied Animal Behavior 3
   ANS 305L Applied Animal Behavior Laboratory 1
   ANS 307 Animal Reproduction 3
   ANS 309 Animal Health and Disease Management 3
ANS 404 Introduction to Quantitative Genetics 3
ANS 407 Food and Animal Toxicology 3
ANS 409 Problems, Controversies and Advancements in Reproduction (W) 4
ANS 413 Non-Ruminant Nutrition 4
ANS 418 Animal Agriculture and the Environment 3
ANS 425 Animal Biotechnology 3
ANS 435 Mammary Physiology 4
ANS 445 Equine Exercise Physiology 4
ANS 455 Avian Physiology 4
ANS 483 Ruminant Nutrition 3

Courses used to fulfill this requirement may not be used to fulfill requirement 3. e. above.

Animal Biology and Prevetinary (32 to 39 credits):
1. All of the following courses (11 credits):
   BS 162 Organismal and Population Biology 3
   BS 172 Organismal and Population Biology 2
   CEM 161 Chemistry Laboratory I 1
   CEM 252 Organic Chemistry II 3
   CEM 255 Organic Chemistry Laboratory 2
2. One of the following courses (4 credits):
   BMB 200 Introduction to Biochemistry 4
   BMB 401 Comprehensive Biochemistry 4
3. A minimum of 9 credits from the following courses (9 to 12 credits):
   ANS 404 Introduction to Quantitative Genetics 3
   ANS 409 Problems, Controversies and Advancements in Reproduction (W) 4
   ANS 413 Non-Ruminant Nutrition 4
   ANS 418 Animal Agriculture and the Environment 3
   ANS 425 Animal Biotechnology 3
   ANS 427 Environmental Toxicology and Society 3
   ANS 435 Mammary Physiology 4
   ANS 445 Equine Exercise Physiology 4
   ANS 455 Avian Physiology 4
   ANS 483 Ruminant Nutrition 3
4. A minimum of 8 credits from the following courses (8 to 12 credits):
   IBIO 313 Animal Behavior 3
   IBIO 341 Fundamental Genetics 4
   MMG 301 Introductory Microbiology 3
   MMG 302 Introductory Laboratory for General and Allied Health Microbiology 1
   MMG 409 Eukaryotic Cell Biology 3
   PHM 450 Introduction to Chemical Toxicology 3
   PHY 231 Introductory Physics I 3
   PHY 232 Introductory Physics II 3
   PHY 251 Introductory Physics Laboratory I 1
   PHY 252 Introductory Physics Laboratory II 1

Companion and Exotic Animal Biology (30 to 33 credits)
1. All of the following courses (17 credits):
   ANS 482 Advanced Companion Animal Management 3
   BS 162 Organismal and Population Biology 3
   BS 172 Organismal and Population Biology Laboratory 2
   CEM 252 Organic Chemistry II 3
   CEM 255 Organic Chemistry Laboratory 2
   IBIO 328 Comparative Anatomy and Biology of Vertebrates 4
   ANS 482 cannot be used to fulfill requirement 3. f. above.
2. One of the following courses (4 credits):
   BMB 200 Introduction to Biochemistry 4
   BMB 401 Comprehensive Biochemistry 4
3. A minimum of 9 credits from the following courses (9 to 12 credits):
   ANS 305 Applied Animal Behavior 3
   ANS 305L Applied Animal Behavior Laboratory 1
   ANS 307 Animal Reproduction 3
2. Request to change the requirements for the Bachelor of Science degree in Nutritional Sciences in the Department of Food Science and Human Nutrition.

The concentrations in the Bachelor of Science degree in Nutritional Sciences are noted on the student’s academic record when the requirements for the degree have been completed.

a. Under the heading Requirements for the Bachelor of Science Degree in Nutritional Sciences make the following changes:

(1) In item 3. b. under the Biomedical and Molecular Nutrition concentration, make the following changes:

(a) In item (7) delete the following course:

IBIO 408 Histology

Add the following courses:

IBIO 450 Cancer Biology (W)
MMG 451 Immunology
PHL 344 Ethical Issues in Healthcare
PSY 333 The Neurobiology of Food Intake and Overeating

(2) In item 3. b. under the Global Nutrition and Health concentration, make the following changes:

(a) Change the total credits from ’42 to 47’ to ’42 to 49’.

(b) In item (1) change the credits from ‘23’ to ’17’ and delete the following courses:

CSUS 215 International Development and Sustainability
SOC 362 Developing Societies

(c) In item (3) change the credits from ‘2 to 4’ to ‘2 or 3’ and delete the following courses:
(d) Renumber item (7) to item (8) and replace with the following:

Two of the following courses (6 to 8 credits):
- ANP 270 Women and Health: Anthropological and International Perspectives 3
- ANP 370 Culture, Health, and Illness 3
- CSS 431 International Agricultural Systems 3
- CSUS 215 International Development and Sustainability 3
- CSUS 463 Food Fight: Politics of Food 3
- EEM 260 World Food Population and Poverty 3
- GEO 235 Geography of Environment and Health 3
- GEO 435 Geography of Health and Disease 3
- GLG 446 Ecosystems Modeling, Water and Food Security 3
- GSAH 230 Values, Experience, and Difference in Global Contexts 3
- MC 337 Global Public Health 4
- MC 430 Applied International Development 4
- PHL 452 Ethics and Development 3
- PHL 453 Ethical Issues in Global Public Health 3
- SOC 161 International Development and Change 3
- SOC 362 Developing Societies 3

A course used to fulfill requirement (7) in this concentration may not be used to fulfill this requirement.

(e) Add the following item (7):

One of the following courses (3 or 4 credits):
- CSUS 215 International Development and Sustainability 3
- MC 430 Applied International Development 4
- SOC 161 International Development and Change 3
- SOC 362 Developing Societies 3

(3) In item 3. b. under the Public Health Nutrition concentration, make the following changes:

(a) Change the total credits from '40 to 43' to '40 to 44'.

(b) In item (5) change the total credits from '6 or 7' to '6 to 8' and delete the following course:

- EPI 240 Epidemiological Investigations in Nutrition and Health 3

Add the following courses:
- CSUS 463 Food Fight: Politics of Food 3
- MC 337 Global Public Health 4

Effective Fall 2019.
3. Request to change the requirements of the **Bachelor of Science** degree in **Packaging** in the School of Packaging.

*The concentrations in the Bachelor of Science degree in Packaging are noted on the student’s academic record when the requirements for the degree have been completed.*

a. Under the heading **Requirements for the Bachelor of Science Degree in Packaging** make the following changes:

1. Replace item 1., paragraph two, with the following:

   The University’s Tier II writing requirement for the Packaging major is met by completing Packaging 485. That course is referenced in item 3. below.

2. In item 3. a. make the following changes:

   a) Change the total credits from '57' to '55'.
   
   b) Delete the following courses:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>PKG 485</td>
<td>Packaging Development</td>
<td>3</td>
</tr>
<tr>
<td>PKG 486</td>
<td>Packaging Senior Capstone (W)</td>
<td>3</td>
</tr>
</tbody>
</table>

   Add the following course:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>PKG 485</td>
<td>Packaging Development (W)</td>
<td>4</td>
</tr>
</tbody>
</table>

Effective Summer 2020.

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**COLLEGE OF ENGINEERING**

1. Request to establish a **Bachelor of Science** degree in **Computational Data Science** in the Department of Computer Science and Engineering. The University Committee on Undergraduate Education (UCUE) recommended approval of this request at its February 21, 2019 meeting.

a. **Background Information:**

Data science is an interdisciplinary field whose purpose is the extraction of actionable insights from data in its many forms. Data science employs theories and techniques drawn from various disciplines, including statistics, mathematics, computer science, and information science. Working data scientists use computational and analytical skills to do many things: to integrate, process, and interpret data from rich and diverse sources, or from large and potentially distributed data sets; to build mathematical models that can infer meaningful relationships in the data and can in turn be used for interpretation and prediction purposes; to create visualizations to aid in the understanding of their data and models; and to communicate their findings and insights to a variety of audiences so that decisions can be made and actions taken. Given the exponential increase in the size and complexity of datasets in virtually all industries, there is a rapidly growing demand for students with these skills (see, e.g., [https://hbr.org/2012/10/data-scientist-the-sexiest-job-of-the-21st-century](https://hbr.org/2012/10/data-scientist-the-sexiest-job-of-the-21st-century) and [https://www.mckinsey.com/business-functions/digital-mckinsey/our-insights/big-data-the-next-frontier-for-innovation](https://www.mckinsey.com/business-functions/digital-mckinsey/our-insights/big-data-the-next-frontier-for-innovation)).

A practicing data scientist needs these skills to have a long and successful career and additionally must learn to think critically about the process of understanding and interpreting data. It is impractical for individual students to acquire all of the requisite skills using existing majors at Michigan State University, and a challenge to students and advisors alike is to determine the educational experiences that will be most important in maximizing their long-term job prospects. As a result, the Department of Computer Science and Engineering, working with the Departments of Statistics and Probability, and Computational Mathematics, Science and Engineering, proposes a new degree program, a Bachelor of Science in Computational Data Science. This major will provide students with an understanding of, and practical experience with, the key aspects of computer science, information science, statistics, and mathematics that are required to manipulate, analyze,
and visualize large and complex datasets. The program will emphasize the algorithmic concepts necessary to build software systems for these operations. Additionally, students in this major will learn to think critically about the data and processes they are working with and to communicate their analysis and results to a variety of audiences.

The degree program is based on courses administered by the Department of Computer Science and Engineering, the Department of Computational Mathematics, Science and Engineering, and the Department of Statistics and Probability. Due to the different needs of the student populations in the Colleges of Natural Science and Engineering, there is a plan to offer two related, but different, bachelor's degrees – a Bachelor of Science in Computational Data Science led by the Department of Computer Science and Engineering in the College of Engineering and a Bachelor of Science in Data Science led by the Department of Computational Mathematics, Science and Engineering in the College of Natural Science. The Departments of Computer Science and Engineering, Computational Mathematics, Science and Engineering, and Statistics and Probability each have faculty with unique expertise that is required to create these degree programs and sharing core courses will ensure that all three departments have a strong stake in the success of implementing, maintaining, and improving both degree programs.

Data science is rapidly becoming a popular program at many institutions. There are more than 100 active Data Science degree programs worldwide. Example programs include a B.S. degree in Data Analytics at Ohio State University and the B.S. and B.A. degrees in Data Science at the University of Rochester. The concept of multiple/parallel degree programs that share a common core has numerous precedents. The University of Michigan offers two B.S. degrees in Data Science, one administered by Statistics in the College of Literature, Science, and the Arts and the other administered by the Department of Electrical Engineering and Computer Science in the College of Engineering. Pennsylvania State University offers a B.S. in Data Science with specializations in Applied Data Sciences, Computational Data Sciences, and Statistical Modeling Data Sciences, each administered by a different department.

Michigan State University is an ideal setting to create a new degree in data science. There are faculty in several departments, such as Computer Science and Engineering (CSE) and Statistics and Probability (STT), whose research expertise lie in aspects of the computational and mathematical algorithms that are key to data science - in statistical analysis, machine learning, database systems, data mining, information retrieval, network analysis, signal processing, computer vision, and high performance computing - and MSU has been aggressively hiring faculty that apply these techniques to applications in a wide range of subject areas. This is further exemplified by the creation of the new Department of Computational Mathematics, Science and Engineering, which explicitly brings together faculty whose interests are in the algorithms and applications of computational modeling and data science techniques, as well as the Social Science Data Analytics initiative, which applies the tools of data science to topics outside of the traditional STEM fields. Additionally, several relevant courses in data science-related subjects have already been developed in these units, providing a base upon which to build a degree program.

There is significant student demand for these skills: MSU students have self-organized into an MSU Data Science student organization (see http://msudatascience.com; this organization sees approximately 100 attendees at its events) and has been inviting speakers, hosting workshops, and distributing job postings to its members. Data Science-related elective offerings in the Department of Computer Science and Engineering are in high demand. These institutional trends support the creation of a degree in data science and ensure that the resources to maintain a thriving degree program will continue to exist far into the future.

b. **Academic Programs Catalog Text:**

The Bachelor of Science degree in Computational Data Science focuses on the computational foundations of data science, providing an in-depth understanding of the algorithms and data structures for storing, manipulating, visualizing, and learning from large data sets. Students in the program have unique access to a wide range of fundamental computer science courses in topics ranging from mobile application and web development to theory of computation and fundamental algorithms. Students can tailor their degree to their own unique interests and requirements, with an emphasis on computational foundations.

The Bachelor of Science degree program in Computational Data Science is accredited by the Computing Accreditation Commission of ABET, [www.abet.org](http://www.abet.org).
Requirements for the Bachelor of Science Degree in Computational Data Science

1. The University requirements for bachelor's degrees as described in the Undergraduate Education section of this catalog; 120 credits, including general elective credits, are required for the Bachelor of Science degree in Computational Data Science.

The University's Tier II writing requirement for the Computational Data Science major is met by completing Computational Mathematics, Science and Engineering 495, referenced in item 3. b. below.

Students who are enrolled in the College of Engineering may complete the alternative track to Integrative Studies in Biological and Physical Sciences that is described in item 1. under the heading Graduation Requirements for All Majors in the College statement.

2. The requirements of the College of Engineering for the Bachelor of Science degree.

The credits earned in certain courses referenced in requirement 3. below may be counted toward College requirements as appropriate.

3. The following requirements for the major:

<table>
<thead>
<tr>
<th>CREDITS</th>
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<tbody>
<tr>
<td><strong>a. Bioscience (4 to 6 credits)</strong></td>
<td></td>
</tr>
<tr>
<td>(1) One of the following courses:</td>
<td></td>
</tr>
<tr>
<td>BS 161 Cell and Molecular Biology</td>
<td>3</td>
</tr>
<tr>
<td>ENT 205 Pests, Society and Environment</td>
<td>3</td>
</tr>
<tr>
<td>IBIO 150 Integrating Biology: From DNA to Populations</td>
<td>3</td>
</tr>
<tr>
<td>MMG 141 Introductory Human Genetics</td>
<td>3</td>
</tr>
<tr>
<td>MMG 201 Fundamentals of Microbiology</td>
<td>3</td>
</tr>
<tr>
<td>PLB 105 Plant Biology</td>
<td>3</td>
</tr>
<tr>
<td>PSL 250 Introductory Physiology</td>
<td>4</td>
</tr>
<tr>
<td>(2) One of the following courses:</td>
<td></td>
</tr>
<tr>
<td>BS 171 Cell and Molecular Biology Laboratory</td>
<td>2</td>
</tr>
<tr>
<td>CEM 161 Chemistry Laboratory I</td>
<td>1</td>
</tr>
<tr>
<td>CEM 162 Chemistry Laboratory II</td>
<td>1</td>
</tr>
<tr>
<td>PHY 191 Physics Laboratory for Scientists I</td>
<td>1</td>
</tr>
<tr>
<td>PHY 192 Physics Laboratory for Scientists II</td>
<td>1</td>
</tr>
<tr>
<td>PLB 106 Plant Biology Laboratory</td>
<td>1</td>
</tr>
</tbody>
</table>

| |
| **b. All of the following courses (43 credits):** | |
| CMSE 201 Introduction to Computational Modeling | 4 |
| CMSE 381 Fundamentals of Data Science Methods | 4 |
| CMSE 382 Optimization Methods in Data Science | 4 |
| CMSE 495 Experiential Learning in Data Science (W) | 4 |
| CSE 232 Introduction to Programming II | 4 |
| CSE 331 Algorithms and Data Structures | 3 |
| CSE 404 Introduction to Machine Learning | 3 |
| CSE 482 Big Data Analysis | 3 |
| CSE 480 Database Systems | 3 |
| MTH 314 Matrix Algebra with Computational Applications | 3 |
| STT 180 Introduction to Data Science | 4 |
| STT 380 Probability and Statistics for Data Science | 4 |

| |
| **c. Two courses selected from the following (6 credits):** | |
| CSE 402 Biometrics and Pattern Recognition | 3 |
| CSE 415 Introduction to Parallel Computing | 3 |
| CSE 431 Algorithm Engineering | 3 |
| CSE 440 Introduction to Artificial Intelligence | 3 |

Computer Science and Engineering 415 and Computational Science, Mathematics and Engineering 401 may not be used to fulfill both requirements c. and d.

| |
| **d. Two courses selected from the following (6 credits):** | |
| CMSE 401 Methods for Parallel Computing | 4 |
| CMSE 402 Visualization of Scientific Datasets | 3 |
| CSE 402 Biometrics and Pattern Recognition | 3 |
Effective Fall 2019.

**COLLEGE OF NATURAL SCIENCE**

1. Request to change the Graduation Requirements for the Bachelor of Arts and Bachelor of Science degrees in the College of Natural Science. The University Committee on Undergraduate Education will consider this request.

   a. Under the heading Graduation Requirements make the following change in paragraph two, following item 3.:

   (1) Replace item 2. c. with the following:

   A minimum of 30 credits in courses numbered 300 and above.

Effective Fall 2019.

2. Request to establish a Bachelor of Science degree in Data Science in the Department of Computational Mathematics, Science, and Engineering. The University Committee on Undergraduate Education (UCUE) recommended approval of this request at its February 21, 2019 meeting.

   a. **Background Information:**

   Data science is an interdisciplinary field whose purpose is the extraction of actionable insights from data in its many forms. Data science employs theories and techniques drawn from various disciplines, including statistics, mathematics, computer science, and information science. Working data scientists use their computational and analytical skills to do many things: to integrate, process, and interpret data from rich and diverse sources, or from large and potentially distributed data sets; to build mathematical models that can infer meaningful relationships in the data and can in turn be used for interpretation and prediction purposes; to create visualizations to aid in the understanding of their data and models; and to communicate their findings and insights to a variety of audiences so that decisions can be made and action can be taken. Given the exponential increase in the size and complexity of datasets in virtually all industries, there is a rapidly growing demand for students with these skills (see https://hbr.org/2012/10/data-scientist-the-sexiest-job-of-the-21st-century and http://www.mckinsey.com/business-functions/digital-mckinsey/our-insights/big-data-the-next-frontier-for-innovation).

   A practicing data scientist needs all of the skills described above in order to have a long and successful career, and additionally must learn to think critically about the process of understanding and interpreting data. It is impractical for individual students to acquire all of these skills using existing majors at Michigan State University. A challenge to students and advisors alike is to determine the educational experiences that will be most important to maximize their long-term job prospects. As a result, the Departments of Computer Science and Engineering, Statistics and Probability, and Computational Mathematics, Science, and Engineering jointly will provide
resources to create a new Bachelor of Science in Data Science. The Department of Computational Mathematics, Science, and Engineering will be the administrative unit. This major will provide students with an understanding of, and practical experience with, the key aspects of statistics, mathematics, computer science, and information science that are required to manipulate, analyze, and visualize large and complex datasets. Additionally, students in this major will learn to think critically about the data and processes they are working with and to communicate their analysis and results to a variety of audiences.

Each of these departments have faculty with unique expertise that is required to create such a degree, and jointly managing the program will ensure that all three departments have a strong stake in the success of implementing, maintaining, and improving the degree program. Due to the different needs of the student populations in the Colleges of Natural Science and Engineering, MSU plans to offer two related, but different, bachelor’s degrees - one led by the Department of Computational Mathematics, Science, and Engineering in the College of Natural Science, and the other led by the Department of Computer Science and Engineering in the College of Engineering.

Michigan State University is an ideal setting to create a new degree in data science. With key faculty in across departments whose research expertise is in aspects of the computational and mathematical algorithms that are key to data science - in statistical analysis, machine learning, database systems, data mining, information retrieval, network analysis, signal processing, computer vision, and high performance computing - MSU has been aggressively hiring faculty that apply these techniques to applications in a wide range of subject areas. This is further exemplified by the creation of the new Department of Computational Mathematics, Science, and Engineering (CMSE), which explicitly brings together faculty whose interests are in the algorithms and applications of computational modeling and data science techniques, as well as the Social Science Data Analytics initiative, which applies the tools of data science to topics outside of the traditional STEM fields. Additionally, several relevant courses in data science-related subjects have already been developed in these units, providing a base upon which to build a degree program. Furthermore, there is significant student demand for these skills: MSU students have self-organized into an MSU Data Science student organization. See http://msudatascience.com/. This organization sees approximately 100 attendees at its events, and has been inviting speakers, hosting workshops, and distributing job postings to its members. These institutional trends support the creation of a degree in data science and ensure that the resources to maintain a thriving degree program will continue to exist far into the future.

A substantial number of universities have created data science degrees in the last few years. In the Big 10, Penn State, Ohio State, and the University of Michigan have all developed a Bachelor of Science degree in Data Science with learning goals and course progressions that are similar to those outlined below. Interestingly, all of these programs are collaborative efforts between multiple departments: typically some combination of computer science, electrical engineering, and/or statistics. Nationwide, there are approximately twenty bachelor programs in data science available, and a comparable number of master’s programs in data science, data analytics, or business analytics.

Broadly speaking the goals of this degree are to provide a solid foundation in the core principles, methods, and tools of data science, as well as to be able to apply these to solve important data-centric problems in a wide variety of disciplines by application of the scientific method. More specifically, a student graduating with a Bachelor’s of Science in Data Science from MSU will be able to: (1) Understand and be able to apply mathematical and statistical models and concepts to detect patterns that exist in datasets, and to draw inferences and conclusions supported by that data; (2) Understand and be able to apply computer science principles relating to algorithm analysis, software design, data representation and retrieval, and programming; (3) Demonstrate critical thinking skills associated with the concepts and practices described above by using the scientific methods to reason effectively with data to identify and solve problems, to inform decision making, and to generate a logical synthesis of information from disparate sources of data; and (4) Clearly communicate their findings and the implications of those findings both orally and in writing, and to do so effectively in a variety of organizational contexts.

b. Academic Programs Catalog Text:

The Bachelor of Science degree in Data Science is designed to provide students with a strong background in data science using a broad range of computational techniques, practice in statistical thinking, as well as in-depth exposure to topics in data science.
Requirements for the Bachelor of Science Degree in Data Science

1. The University requirements for bachelor's degrees as described in the Undergraduate Education section of this catalog; 120 credits, including general elective credits, are required for the Bachelor of Science degree in Data Science. The University’s Tier II writing requirement for the Data Science major is met by completing Computational Mathematics, Science and Engineering 495, referenced in item 3. below.

2. The requirements of the College of Natural Science for the Bachelor of Science degree.

3. The following requirements for the major:

CREDITS

a. One course from each of the following groups (8 or 10 credits):
   (1) CEM 141 General Chemistry 4
       CEM 151 General and Descriptive Chemistry 4
       CEM 181H Honors Chemistry I 4
       LB 171 Principles of Chemistry I 4
   (2) CEM 142 General and Inorganic Chemistry 3
       CEM 152 Principles of Chemistry 3
       CEM 182H Honors Chemistry II 4
       LB 172 Principles of Chemistry II 3
   (3) CEM 161 Chemistry Laboratory I 1
       CEM 185H Honors Chemistry Laboratory I 2
       LB 171L Introductory Chemistry Laboratory I 1

b. One course from each of the following groups (8 credits):
   (1) LB 273 Physics I 4
       PHY 183 Physics for Scientists and Engineers I 4
   (2) LB 274 Physics II 4
       PHY 184 Physics for Scientists and Engineers II 4

c. One course from each of the following groups (14 or 15 credits):
   (1) LB 118 Calculus I 4
       MTH 132 Calculus I 3
       MTH 152H Honors Calculus I 3
   (2) LB 119 Calculus II 4
       MTH 133 Calculus II 4
       MTH 153H Honors Calculus II 4
   (3) LB 220 Calculus III 4
       MTH 234 Multivariable Calculus 4
       MTH 254H Honors Multivariable Calculus 4
   (4) MTH 314 Matrix Algebra with Computational Applications 3

d. One of the following groups (4 or 6 credits):
   (1) STT 380 Probability and Statistics for Data Science 4
   (2) STT 441 Probability and Statistics I: Probability 3
       STT 442 Probability and Statistics I: Statistics 3

e. All of the following courses (31 credits):
   CMSE 201 Introduction to Computational Modeling and Data Analysis 4
   CMSE 202 Computational Modeling Tools and Techniques 4
   CMSE 381 Fundamentals of Data Science Methods 4
   CMSE 382 Optimization Methods in Data Science 4
   CMSE 495 Experiential Learning in Data Science (W) 4
   CSE 232 Introduction to Programming II 4
   CSE 331 Algorithms and Data Structures 3
   STT 180 Introduction to Data Science 4

f. A minimum of 12 credits of approved 400-level courses or above. The following courses are eligible to fulfill this requirement. Other may be substituted with advisor approval.
   CMSE 401 Methods for Parallel Computing 4
   CMSE 402 Data Visualization Principles and Techniques 3
   CMSE 410 Computational Biology and Bioinformatics 3
   CMSE 411 Computational Medicine 3
   CMSE 492 Special Topics in Data Science 1 to 4
   CSE 402 Biometrics and Pattern Recognition 3
   CSE 440 Introduction to Artificial Intelligence 3
   CSE 480 Database Systems 3
CSE 482 Big Data Analysis     3
MTH 468 Predictive Analytics    3
STT 464 Statistics for Biologists   3
STT 465 Bayesian Statistical Methods   3

A maximum of 12 credits may count towards the degree for enrollments in CMSE 492 with advisor approval.

Effective Fall 2019.

3. Request to establish a **Minor in Data Science** in the Department of Computational Mathematics, Science, and Engineering. The University Committee on Undergraduate Education (UCUE) recommended approval of this request at its February 21, 2019 meeting.

   a. **Background Information:**

   Data science is an interdisciplinary field whose purpose is the extraction of actionable insights from data in its many forms. Data science employs theories and techniques drawn from various disciplines, including statistics, mathematics, computer science, and information science. Working data scientists use their computational and analytical skills to do many things: to integrate, process, and interpret data from rich and diverse sources, or from large and potentially distributed data sets; to build mathematical models that can infer meaningful relationships in the data and can in turn be used for interpretation and prediction purposes; to create visualizations to aid in the understanding of their data and models; and to communicate their findings and insights to a variety of audiences so that decisions can be made and action can be taken. Given the exponential increase in the size and complexity of datasets in virtually all industries, there is a rapidly growing demand for students with these skills (see [https://hbr.org/2012/10/data-scientist-the-sexiest-job-of-the-21st-century](https://hbr.org/2012/10/data-scientist-the-sexiest-job-of-the-21st-century) and [http://www.mckinsey.com/business-functions/digital-mckinsey/our-insights/big-data-the-next-frontier-for-innovation](http://www.mckinsey.com/business-functions/digital-mckinsey/our-insights/big-data-the-next-frontier-for-innovation)).

   A practicing data scientist needs all of the skills described above in order to have a long and successful career, and additionally must learn to think critically about the process of understanding and interpreting data. It is impractical for individual students to acquire all of these skills using existing minors at Michigan State University. A challenge to students and advisors alike is to determine the educational experiences that will be most important to maximize their long-term job prospects. As a result, the Department of Statistics and Probability, and Computational Mathematics, Science, and Engineering jointly will provide resources to create a new Minor in Data Science. The Department of Computational Mathematics, Science, and Engineering will be the administrative unit. This minor will provide students with an understanding of, and practical experience with, the key aspects of statistics, mathematics, computer science, and information science that are required to manipulate, analyze, and visualize large and complex datasets. Additionally, students in this minor will learn to think critically about the data and processes they are working with and to communicate their analysis and results to a variety of audiences.

   Each of these departments have faculty with unique expertise that is required to create such the minor, and jointly managing the program will ensure that both departments have a strong stake in the success of implementing, maintaining, and improving the program.

   Michigan State University is an ideal setting to create a minor in data science. With key faculty in across departments whose research expertise is in aspects of the computational and mathematical algorithms that are key to data science - in statistical analysis, machine learning, database systems, data mining, information retrieval, network analysis, signal processing, computer vision, and high performance computing - MSU has been aggressively hiring faculty that apply these techniques to applications in a wide range of subject areas. This is further exemplified by the creation of the new Department of Computational Mathematics, Science, and Engineering (CMSE), which explicitly brings together faculty whose interests are in the algorithms and applications of computational modeling and data science techniques, as well as the Social Science Data Analytics initiative, which applies the tools of data science to topics outside of the traditional STEM fields. Additionally, several relevant courses in data science-related subjects have already been developed in these units, providing a base upon which to build a degree program. Furthermore, there is significant student demand for these skills: MSU students have self-organized into an MSU Data Science student organization. See [http://msudatascience.com/](http://msudatascience.com/). This organization sees approximately 100 attendees at its events, and has been inviting speakers, hosting workshops, and distributing job postings to its members. These institutional trends support the creation of a degree
in data science and ensure that the resources to maintain a thriving degree program will continue to exist far into the future.

A substantial number of universities have created data science degrees in the last few years. In the Big 10, Penn State, Ohio State, and the University of Michigan have all developed a Bachelor of Science degree in Data Science with learning goals and course progressions that are similar to those outlined below. Interestingly, all of these programs are collaborative efforts between multiple departments: typically some combination of computer science, electrical engineering, and/or statistics. Nationwide, there are approximately twenty bachelor programs in data science available, and a comparable number of master’s programs in data science, data analytics, or business analytics. Many of these programs also offer minors.

Broadly speaking the goals are to provide a solid foundation in the core principles, methods, and tools of data science, as well as to be able to apply these to solve important data-centric problems in a wide variety of disciplines by application of the scientific method. More specifically, a student graduating with a Minor in Data Science from MSU will be able to: (1) Understand and be able to apply mathematical and statistical models and concepts to detect patterns that exist in datasets, and to draw inferences and conclusions supported by that data; (2) Understand and be able to apply computer science principles relating to algorithm analysis, software design, data representation and retrieval, and programming; (3) Demonstrate critical thinking skills associated with the concepts and practices described above by using the scientific methods to reason effectively with data to identify and solve problems, to inform decision making, and to generate a logical synthesis of information from disparate sources of data; and (4) Clearly communicate their findings and the implications of those findings both orally and in writing, and to do so effectively in a variety of organizational contexts.

b. Academic Programs Catalog Text:

The Minor in Data Science, which is administered by the Department of Computational Mathematics, Science, and Engineering, is designed to provide students with a strong background in data science using a broad range of computational techniques, practice in statistical thinking, as well as in-depth exposure to topics in data science.

The minor is available as an elective to students enrolled in bachelor’s degree programs at Michigan State University with the exception of the Bachelor of Science degree in Data Science and the Bachelor of Science Degree in Computational Data Science. With the approval of the department and college that administer the student’s degree program, the courses that are used to satisfy the minor may also be used to satisfy the requirements for the bachelor’s degree.

Students who plan to apply to the program should consult the undergraduate advisor in the Department of Computational Mathematics, Science, and Engineering.

Requirements for the Minor in Data Science

Complete a minimum of 23 credits from the following:

1. All of the following courses (19 credits):
   
<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>CMSE 180</td>
<td>Introduction to Data Science</td>
<td>4</td>
</tr>
<tr>
<td>CMSE 201</td>
<td>Introduction to Computational Modeling</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>and Data Analysis</td>
<td></td>
</tr>
<tr>
<td>CMSE 202</td>
<td>Computational Modeling Tools and Techniques</td>
<td>4</td>
</tr>
<tr>
<td>CMSE 381</td>
<td>Fundamentals of Data Science Methods</td>
<td>4</td>
</tr>
<tr>
<td>MTH 314</td>
<td>Matrix Algebra with Computational Applications</td>
<td>3</td>
</tr>
</tbody>
</table>

2. One of the following groups (4 or 6 credits):

<table>
<thead>
<tr>
<th>Group</th>
<th>Course</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a)</td>
<td>STT 380</td>
<td>Probability and Statistics for Data Science</td>
<td>4</td>
</tr>
<tr>
<td>(b)</td>
<td>STT 441</td>
<td>Probability and Statistics I: Probability</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>STT 442</td>
<td>Probability and Statistics I: Statistics</td>
<td>3</td>
</tr>
</tbody>
</table>

Effective Fall 2019.
COLLEGE OF NURSING

1. Request to change the requirements for the Master of Science in Nursing degree in Nursing. The University Committee on Graduate Studies (UCGS) will consider this request at its April 15, 2019 meeting.

   The concentrations in the Master of Science in Nursing degree in Nursing are noted on the student’s academic record when the requirements for the degree have been completed.

   a. Under the heading Admission make the following changes:

      (1) In item 8., add the following second sentence:

      Recommendations for admission are made by the faculty committee to the Dean of the college based on the requirements for admission and the personal interview.

   b. Under the heading Requirements for the Master of Science in Nursing Degree in Nursing make the following changes:

      (1) Change the total credits required from ‘45 to 48’ to ‘54’

      (2) In item 1., add the following courses:

         NUR 903 Healthcare Informatics 3
         NUR 904 Health Policy and Advocacy 3
         NUR 906 Leadership in Complex Health Systems 3

      (3) Add the following concentration:

         NURSE PRACTITIONER – PSYCHIATRIC MENTAL HEALTH (30 credits)
         EPI  840 Clinical Epidemiology for Healthcare Practice 3
         NUR  952 Psychopharmacology and Neuropathological Basis of Mental Illness 3
         NUR  953 Clinical Diagnosis and Management I – Psychiatric Assessment and Diagnosis 6
         NUR  954 Clinical Diagnosis and Management II – Evidence Based Therapeutic Interventions 6
         NUR  955 Clinical Diagnosis and Management III – Special Populations and Group 6
         NUR  956 Clinical Diagnosis and Management IV – Complex and Collaborative Mental Health Care 6

      (4) In the ADULT-GERONTOLOGY CLINICAL NURSE SPECIALIST concentration make the following changes:

         (a) Change the total credits from ‘33’ to ‘30’.

         (b) Add the following course:

             EPI  840 Clinical Epidemiology for Healthcare Practice 3

         Delete the following courses:

             NUR  904 Health Policy and Advocacy 3
             NUR  906 Leadership in Complex Health Systems 3

Effective Summer 2019.
2. Request to change the requirements for the Doctor of Nursing Practice degree in Nursing Practice. The University Committee on Graduate Studies (UCGS) will consider this request at its April 15, 2019 meeting.

The concentrations in the Doctor of Nursing Practice degree in Nursing Practice are noted on the student's academic record when the requirements for the degree have been completed.

a. Under the heading Requirements for the Doctor of Nursing Practice Degree in Nursing Practice make the following changes:

(1) In item 2., add the following concentration:

NURSE PRACTITIONER – PSYCHIATRIC MENTAL HEALTH (42 credits)
NUR 907 Advanced Pathophysiology for the Advanced Practice Registered Nurse 3
NUR 908 Advanced Physical Assessment for the Advanced Practice Registered Nurse 3
NUR 909 Advanced Pharmacology for the Advanced Practice Registered Nurse 3
NUR 952 Psychopharmacology and Neuropathological Basis of Mental Illness 3
NUR 953 Clinical Diagnosis and Management I – Psychiatric Assessment and Diagnosis 6
NUR 954 Clinical Diagnosis and Management II – Evidence Based Therapeutic Interventions 6
NUR 955 Clinical Diagnosis and Management III – Special Populations and Group 6
NUR 956 Clinical Diagnosis and Management IV – Complex and Collaborative Mental Health Care 6
NUR 957 Clinical Diagnosis and Management V – Clinical Immersion – Psychiatric Mental Health 6

b. Delete the section Guidance Committee.

c. Under the heading Comprehensive Examinations change the credits for the synthesis project from ‘6’ to ‘10’.

Effective Fall 2019.
COLLEGE OF OSTEOPATHIC MEDICINE

1. Request to change the requirements for the Professional Program in Osteopathic Medicine leading to the Doctor of Osteopathic Medicine degree the College of Osteopathic Medicine. The University Committee on Graduate Studies (UCGS) will consider this request at its April 15, 2019 meeting.

a. Under the heading Clerkship Curriculum replace the entire entry with the following:

The clinical clerkship curriculum includes 83 weeks of clinical training in community hospitals, clinics, and private practice offices affiliated with the college from across the State of Michigan.

The third year curriculum consists of 51 weeks, transition from classroom to bedside, ambulatory family medicine, ambulatory internal medicine, ambulatory or in-patient pediatrics, in-patient internal medicine, neurology, psychiatry, obstetrics/gynecology, general surgery, and emergency medicine each in 4-week blocks. In addition, anesthesia and radiology each in 2-week blocks.

The fourth year curriculum consists of 32 weeks. Of those 32 weeks, 12 are required to be completed within our Statewide Campus System hospitals. The remaining 20 weeks are required to be completed within either the Statewide Campus System or any institution approved by the College of Osteopathic Medicine with advanced planning and scheduling on the part of the student. Within the 32 weeks, students will be required to complete 8 weeks in a surgical field and 12 weeks in a medicine related field. A list of possible rotations for each field is available from the College of Osteopathic Medicine.

Effective Fall 2019.
### PART II - NEW COURSES AND CHANGES

**COLLEGE OF AGRICULTURE AND NATURAL RESOURCES**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Schedule</th>
<th>Credits</th>
<th>Remarks</th>
</tr>
</thead>
</table>
| ANS 110     | Introductory Animal Agriculture                  | Fall of every year. Spring of every year.    | 4(3-2) 3(3-0) | R: Open to undergraduate students or agricultural technology students.  
History of animal agriculture and its relationship to human needs, production systems, marketing, and environmental considerations. Current goals of and limitations affecting U.S. farm animal production. Field trips required.  
History of animal agriculture and its relationship to human needs, production systems, marketing, and environmental considerations. Current goals of and limitations affecting U.S. farm animal production.  
SA: ANS 112 |

Effective Spring 2014  Effective Fall 2019 |

| ANS 110L    | Introductory Animal Agriculture Laboratory     | Fall of every year. Spring of every year.    | 1(0-2)  | NEW  
Hands on experience in working with farm and other animals. Field trip required.  
Effective Fall 2019 |

| ANS 201     | Animal Products                               | Fall of every year. Spring of every year.    | 3(3-0)  | RB: ANS 110 R: Not open to freshmen.  
Effective Spring 2014  Effective Spring 2020 |

| ANS 262     | Introductory Sheep Management                 | Fall of every year. Spring of every year.    | 3(2-2)  | NEW  
Principles of sheep management: genetics, reproduction, nutrition, marketing, and economics.  
Effective Fall 2014  Effective Fall 2019 |

| ANS 301     | Professional Development in Animal Science II | Fall of every year. Spring of every year.    | 2(1-2) 3(3-0) | P: (ANS 101 and ANS 110) and completion of Tier I writing requirement.  
P: (ANS 110) and completion of Tier I writing requirement.  
RB: ANS 101 and ANS 110 R: Open to juniors or seniors in the Department of Animal Science.  
Effective Fall 2013  Effective Fall 2019 |

| ANS 305     | Applied Animal Behavior                      | Spring of every year. Summer of every year.  | 3(2-2) 3(3-0) | P: BS 161 or LB 145 or BS 181H  
P: (ANS 210) and (BS 162 or LB 144 or BS 182H)  
Techniques for assessing health and welfare of domestic animals based on their behavior.  
Effective Fall 2013  Effective Fall 2019 |

| ANS 305L    | Applied Animal Behavior Laboratory           | Fall of every year.                         | 1(0-2)  | P: ANS 305  
Understanding of biological basis of behavior to improve animal health, productivity and welfare.  
Effective Fall 2019 |
ANS 307 Animal Reproduction  
Fall of every year. 3(3-0) P: ANS 210  
NEW  Reproductive physiology of farm and companion animals. Comparative reproduction in human and laboratory animals.  
Effective Fall 2019

ANS 313 Principles of Animal Feeding and Nutrition  
Principles of Animal Feeding and Nutrition (W)  
Fall of every year. 4(3-2) P: ((BS 161 or LB 145 or BS 181H) and completion of Tier I writing requirement) and ((CEM 143 or concurrently) or (CEM 251 or concurrently))  
Comparative nutrition and metabolism for production, health, and stewardship of cattle, horses, swine, poultry, dogs and cats. Diet evaluation and formulation. Feeding management.  
Effective Spring 2014 Effective Fall 2019

ANS 314 Genetic Improvement of Domestic Animals  
Genetic Improvement of Domestic Animals (W)  
Fall of every year. Spring of every year. 4(4-0) P: ((BS 161 or BS 181H or LB 145) and completion of Tier I writing requirement) and (STT 200 or STT 201 or STT 421 or STT 464 or STT 231)  
Molecular, Mendelian, population, and quantitative genetics of domestic animals.  
Effective Spring 2014 Effective Spring 2020

ANS 315 Anatomy and Physiology of Farm Animals  
Spring of every year. 4(3-2) P: (BS 161 or LB 145 or BS 181H) and completion of Tier I writing requirement P: BS 161 or LB 145 or BS 181H  
Effective Spring 2014 Effective Spring 2020

ANS 404 Introduction to Quantitative Genetics  
Fall of every year. 3(3-0) P: (ANS 314) and (STT 200 or STT 201 or STT 231 or STT 421 or STT 464)  
NEW  Theories and applications of quantitative genetics; mutations, recombination, selection, and their roles in shaping genetic variation and covariance in idealized and finite populations; analysis of quantitative trait variation and genetic parameters; gene mapping and genetic prediction; applications in breeding.  
Effective Fall 2019

ANS 409 Problems, Controversies and Advancements in Reproduction  
Problems, Controversies and Advancements in Reproduction (W)  
Fall of every year. 3(3-0) 4(4-0) P: (BS 161 or BS 181H or LB 145) and completion of Tier I writing requirement RB: ANS 307  
Selected topics in endocrine, cellular, molecular and genetic aspects of sex differentiation, gametogenesis, folliculogenesis, sexual cycles, behavior, fertilization, early embryo development, pregnancy, parturition, infertility, reproductive disorders, assisted reproductive technologies in humans, livestock and animal models.  
Effective Fall 2014 Effective Fall 2019

ANS 435 Mammary Physiology  
Mammary Physiology (W)  
Spring of every year. 4(4-2) 3(3-0) P: (BS 161 or LB 145 or BS 181H) and (ANS 313 and ANS 315) P: ((BS 161 or LB 145 or BS 181H) and completion of Tier I writing requirement) and (ANS 313 and ANS 315) R: Not open to freshmen and not open to sophomores.  
Effective Spring 2014 Effective Spring 2020
ANS 482  Advanced Companion Animal Management
Spring of every year. 3(2-2) P: ANS 282 and ANS 210 RB: ANS 305 or IBIO 313
NEW Companion animal behavior, welfare, anatomy, physiology, nutrition and health. Careers in the companion animal industry. Experiential learning projects. Field trip required. Effective Spring 2020

TSM 331  Water Management in Agriculture and Food Systems
Spring of every year. 3(3-0) Interdepartmental with Crop and Soil Sciences. P: MTH 103 or MTH 124 or MTH 132 or LB 118
Principles of water management, use efficiency and conservation in agricultural production, natural resources and food processing facilities. Best agricultural water management practices, water rights, irrigation scheduling, irrigation systems selection, evaluation and management and drainage principles. Large scale water use, management and conservation in food processing.
SA: TSM 431 Effective Fall 2015 Effective Fall 2018

FOR 804  Forest Ecology
Fall of odd years. 3(3-0) RB: FOR 404
REINSTATEMENT Processes controlling population, community, ecosystem, landscape, and global ecology of forested systems. Extrapolation across scales, succession, spatial models of forest dynamics, causes and consequences of biodiversity, nutrient cycling, sustainability of managed ecosystems and human-accelerated environmental change. Effective Fall 2019

PKG 485  Packaging Development
Packaging Development (W)
Fall of every year. Spring of every year. 3(3-0) 4(4-0) P: (PKG 410 and PKG 432) and (PKG 315 or EGR 102) and (PKG 411 or concurrently) P: ((PKG 410 and PKG 432) and completion of Tier I writing requirement) and (PKG 315 or EGR 102) and (PKG 411 or concurrently) R: Open to seniors or graduate students in the School of Packaging.
Package development including selection, design and implementation of package systems for protection, distribution, merchandising, use and disposal. Effective Fall 2016 Effective Fall 2019

CSE 331  Algorithms and Data Structures
Fall of every year. Spring of every year. 3(3-0) P: CSE 232 and CSE 260 P: (CSE 232) and (CSE 260 or CMSE 202) R: Open to students in the Department of Computer Science and Engineering or in the Computer Engineering Major or in the Lyman Briggs Computer Science Coordinate Major or in the Lyman Briggs Computer Science Major or the Computer Science Disciplinary Teaching Minor. R: Open to students in the Department of Computer Science and Engineering or in the Computer Engineering Major or in the Lyman Briggs Computer Science Coordinate Major or in the Lyman Briggs Computer Science Major and open to juniors or seniors in the College of Engineering.
Linear data structures, trees, graphs and algorithms which operate on them. Fundamental algorithms for searching, sorting, string matching, graph problems. Design and analysis of algorithms. Effective Spring 2014 Effective Fall 2019

CSE 402  Biometrics and Pattern Recognition
Fall of every year. 3(3-0) P: CSE 331 and STT 351 P: (CSE 331) and (STT 351 or STT 380 or STT 430 or STT 441) R: Open to juniors or seniors in the College of Engineering or in the Computer Science Minor or in the Lyman Briggs Computer Science Coordinate Major or in the Lyman Briggs Computer Science Major.
Automated techniques used for feature extraction and pattern matching focusing on face, fingerprint and iris recognition. Effective Fall 2012 Effective Fall 2019
CSE 404  Introduction to Machine Learning
Fall of every year. 3(3-0) Interdepartmental with Computational Mathematics, Science, and Engineering and Statistics and Probability. P: (CSE 331) and (STT 351 or STT 380 or STT 430 or STT 441) RB: Basic linear algebra R: Open to juniors or seniors in the College of Engineering or in the Computer Science Minor or in the Lyman Briggs Computer Science Coordinate Major or in the Lyman Briggs Computer Science Major.
Effective Fall 2019

CSE 415  Introduction to Parallel Computing
Spring of every year. 3(3-0) P: CSE 320 and CSE 331 R: Open to juniors or seniors in the College of Engineering or in the Computer Science Minor or in the Lyman Briggs Computer Science Coordinate Major or in the Lyman Briggs Computer Science Major. Not open to students with credit in CMSE 401.
Effective Fall 2017 Effective Fall 2019

CSE 482  Big Data Analysis
Spring of every year. 3(3-0) P: CSE 331 and CSE 335 and STT 351 P: (CSE 331) and (STT 351 or STT 380 or STT 430 or STT 441) R: Open to juniors or seniors in the College of Engineering or in the Lyman Briggs Computer Science Coordinate Major or in the Lyman Briggs Computer Science Major.
Data collection, storage, and preprocessing, and analysis techniques. Programming for large-scale data analysis. Case studies and applications.
Effective Spring 2017 Effective Fall 2019

COLLEGE OF HUMAN MEDICINE

EM 632  Senior Clinical Elective in Emergency Medicine
Fall of every year. Spring of every year. Summer of every year. 6 credits. A student may earn a maximum of 24 credits in all enrollments for this course. P: (FM 641 and MED 641 and PHD 641 and PSC 641 and OGR 641 and SUR 641) or (FM 608 and MED 608 and PHD 600 and PSC 608 and OGR 608 and SUR 608) P: (FM 641 or MED 641 or PHD 641 or PSC 641 or OGR 641 or SUR 641) and (FM 641 or MED 641 or PHD 641 or PSC 641 or OGR 641 or SUR 641) and (FM 641 or MED 641 or PHD 641 or PSC 641 or OGR 641 or SUR 641) and (FM 641 or MED 641 or PHD 641 or PSC 641 or OGR 641 or SUR 641) and (FM 641 or MED 641 or PHD 641 or PSC 641 or OGR 641 or SUR 641) and (FM 641 or MED 641 or PHD 641 or PSC 641 or OGR 641 or SUR 641) and (FM 608 and MED 608 and PHD 600 and PSC 608 and OGR 608 and SUR 608) R: Open to graduate-professional students in the College of Human Medicine.
Four-week elective in clinical diagnosis and treatment of the undifferentiated patient in the emergency department setting. Intended for students planning to apply to an Emergency Medicine Residency.
Request the use of the Pass-No Grade (P-N) system.
Request the use of ET-Extension to postpone grading.
The work for the course must be completed and the final grade reported within 2 semesters after the end of the semester of enrollment.
Effective Fall 2018 Effective Summer 2019
MED 628  Advanced Internal Medicine: Senior Medicine Sub-Internship
Fall of every year. Spring of every year. Summer of every year. 3 to 6 credits. A student may earn a maximum of 24 credits in all enrollments for this course. P: MED 608 or MED 641 RB: MED 608 or HM 556 R: Open to graduate-professional students in the College of Human Medicine.
Advanced clinical experiences to refine diagnostic and management skills in complicated general internal medicine patients.
Request the use of the Pass-No Grade (P-N) system.
Request the use of ET-Extension to postpone grading.
The work for the course must be completed and the final grade reported within 2 semesters after the end of the semester of enrollment.
Effective Summer 2019

SUR 615  Ophthalmology Clerkship
Fall of every year. Spring of every year. Summer of every year. 3 to 6 credits. A student may earn a maximum of 24 credits in all enrollments for this course. P: SUR 608 or SUR 641 RB: SUR 608 or SUR 641 R: Open to graduate-professional students in the College of Human Medicine.
Medical and surgical treatment of eye diseases. Clinical experiences include private office practice, surgical observations, pre-and post-operative care.
Request the use of the Pass-No Grade (P-N) system.
Request the use of ET-Extension to postpone grading.
The work for the course must be completed and the final grade reported within 2 semesters after the end of the semester of enrollment.
Effective Fall 2018 Effective Summer 2019

SUR 618  Anesthesia Clerkship
Fall of every year. Spring of every year. Summer of every year. 3 to 6 credits. A student may earn a maximum of 24 credits in all enrollments for this course. P: SUR 608 or SUR 641 RB: SUR 608 or SUR 641 R: Open to graduate-professional students in the College of Human Medicine.
Common anesthetic agents and procedures. Operative and post-operative effects, complications, patient risk, cost. Performing anesthetic procedures under faculty supervision.
Request the use of the Pass-No Grade (P-N) system.
Request the use of ET-Extension to postpone grading.
The work for the course must be completed and the final grade reported within 2 semesters after the end of the semester of enrollment.
Effective Fall 2018 Effective Summer 2019

SUR 630  Surgical Wound Care Clerkship
Fall of every year. Spring of every year. Summer of every year. 3 to 6 credits. A student may earn a maximum of 24 credits in all enrollments for this course. P: SUR 608 or SUR 641 RB: SUR 608 or SUR 641 R: Open to graduate-professional students in the College of Human Medicine.
Evaluation, management and knowledge of wound care in surgical patients.
Request the use of the Pass-No Grade (P-N) system.
Request the use of ET-Extension to postpone grading.
The work for the course must be completed and the final grade reported within 2 semesters after the end of the semester of enrollment.
Effective Fall 2018 Effective Summer 2019

SUR 632  Surgical Nutrition Clerkship
Fall of every year. Spring of every year. Summer of every year. 3 to 6 credits. A student may earn a maximum of 24 credits in all enrollments for this course. P: SUR 608 or SUR 641 RB: SUR 608 or SUR 641 R: Open to graduate-professional students in the College of Human Medicine.
Evaluation, management and knowledge of nutrition in critically-ill surgical patients.
Request the use of the Pass-No Grade (P-N) system.
Request the use of ET-Extension to postpone grading.
The work for the course must be completed and the final grade reported within 2 semesters after the end of the semester of enrollment.
Effective Fall 2018 Effective Summer 2019
## COLLEGE OF NATURAL SCIENCE

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Terms</th>
<th>Credits</th>
<th>Interdepartmental with</th>
<th>Prerequisites</th>
<th>Effective Fall</th>
</tr>
</thead>
<tbody>
<tr>
<td>CMSE 381</td>
<td>Fundamentals of Data Science Methods</td>
<td>Fall of every year. Spring of every year.</td>
<td>4(4-0)</td>
<td>Interdepartmental with Statistics and Probability.</td>
<td>P: (STT 180 and MTH 314 and CMSE 201 and STT 380) or (STT 180 and MTH 314 and CMSE 201 and CMSE 441 and STT 442)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>NEW</td>
<td></td>
<td></td>
<td>Fundamental concepts of data science methods, including unsupervised learning and supervised learning, feature extraction, dimension reduction, clustering, regression and classification.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CMSE 382</td>
<td>Optimization Methods in Data Science</td>
<td>Fall of every year. Spring of every year.</td>
<td>4(4-0)</td>
<td></td>
<td>P: CMSE 202 and CMSE 381</td>
<td></td>
</tr>
<tr>
<td></td>
<td>NEW</td>
<td></td>
<td></td>
<td>Concepts, mathematical foundations, methods, and algorithms of optimization in data modeling, all applied to modeling real-world data.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CMSE 492</td>
<td>Selected Topics in Data Science</td>
<td>Fall of every year. Spring of every year.</td>
<td>1 to 4</td>
<td>Interdepartmental with Computer Science and Engineering and Statistics and Probability.</td>
<td>A student may earn a maximum of 12 credits in all enrollments for this course. R: Approval of department.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>NEW</td>
<td></td>
<td></td>
<td>Topics selected to supplement and enrich existing courses in Data Science.</td>
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<td></td>
</tr>
<tr>
<td>CMSE 495</td>
<td>Experiential Learning in Data Science (W)</td>
<td>Fall of every year. Spring of every year.</td>
<td>4(2-4)</td>
<td>Interdepartmental with Computer Science and Engineering and Statistics and Probability.</td>
<td>P: (CSE 232 and CMSE 382) and completion of Tier I writing requirement R: Open to seniors.</td>
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<td></td>
<td>NEW</td>
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<td>Team-based data science projects on realistic, large-scale data.</td>
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<td>STT 180</td>
<td>Introduction to Data Science</td>
<td>Fall of every year. Spring of every year.</td>
<td>4(4-0)</td>
<td>Interdepartmental with Computational Mathematics, Science, and Engineering.</td>
<td>P: (MTH 124 or concurrently) or (MTH 132 or concurrently) or (MTH 152H or concurrently) or (LB 118 or concurrently) Not open to students with credit in STT 301.</td>
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<td>NEW</td>
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<td>Pervasiveness and utility of data in modern society; obtaining and managing data; summarizing and visualizing data; ethical issues in data science; communication with data; fundamentals of probability and statistics; all in the context of the statistical software R.</td>
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<tr>
<td>STT 380</td>
<td>Probability and Statistics for Data Science</td>
<td>Fall of every year. Spring of every year.</td>
<td>4(4-0)</td>
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<td>P: ((MTH 234 or concurrently) or (MTH 254H or concurrently) or (LB 220 or concurrently) or (MTH 314 or concurrently)</td>
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<td></td>
<td>NEW</td>
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<td>Fundamental concepts and methods in probability and statistics from a data science perspective</td>
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<tr>
<td>STT 804</td>
<td>Statistical Consulting and Practice</td>
<td>Fall of every year. Spring of every year.</td>
<td>3(3-0)</td>
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<td>R: Excellent command of English language due to reading research articles in applied fields R: Open to master's students in the College of Natural Science or in the Department of Statistics and Probability or in the Statistics Major. Approval of department.</td>
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<td>NEW</td>
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<td>This course will provide a discussion-based introduction to statistical consulting and the practical aspects of the consulting environment. This course is geared towards quantitative graduate students of various disciplines in their second-year master’s program. Students will be asked to work on consulting projects, write statistical reports, and give presentations, gaining soft skills that are not necessarily covered in other courses. Covered topics will include aspects of the consulting process including (a) ethics; (b) communication skills; (c) data management and statistical methods.</td>
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<tr>
<td>COURSE CODE</td>
<td>COURSE TITLE</td>
<td>Term(s) Offered</td>
<td>Credits</td>
<td>Prerequisites</td>
<td>Notes</td>
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<td>NUR 434</td>
<td>Nursing Care of Acute and Chronically Ill Patients III</td>
<td>Fall of every year. Spring of every year.</td>
<td>4(2-6)</td>
<td>P: NUR 337 and NUR 371 and NUR 342</td>
<td>Nursing process and clinical judgment to manage and evaluate care for acute and critically ill patients at an advanced level. Effective Fall 2019</td>
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<tr>
<td>NUR 952</td>
<td>Psychopharmacology and Neuropathological Basis of Mental Illness</td>
<td>Summer of every year.</td>
<td>3(3-0)</td>
<td>R: Open to graduate students or lifelong graduate students in the College of Nursing.</td>
<td>Application of advanced pharmacology and psycho-pharmacotherapeutics and the putative neuropathophysiology of common psychiatric illnesses that occur across the lifespan. Effective Spring 2020</td>
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<tr>
<td>NUR 953</td>
<td>Clinical Diagnosis &amp; Management I - Psychiatric Assessment and Diagnosis</td>
<td>Fall of every year.</td>
<td>6(3-9)</td>
<td>P: NUR 907 and NUR 908 and NUR 909 and NUR 952</td>
<td>R: Open to graduate students in the College of Nursing. Integration of mental health assessment and diagnostic screening to formulate differential diagnoses for common mental health conditions/problems across the lifespan. Effective Spring 2020</td>
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<tr>
<td>NUR 954</td>
<td>Clinical Diagnosis &amp; Management II – Evidence-Based Therapeutic Interventions</td>
<td>Spring of every year.</td>
<td>6(3-9)</td>
<td>P: NUR 953</td>
<td>R: Open to graduate students in the College of Nursing. Integration of assessment and intervention strategies for health promotion and common mental health problems in the clinical setting across the lifespan. Effective Spring 2020</td>
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<tr>
<td>NUR 955</td>
<td>Clinical Diagnosis &amp; Management III – Special Populations and Group</td>
<td>Summer of every year.</td>
<td>6(3-9)</td>
<td>P: NUR 954</td>
<td>R: Open to graduate students in the College of Nursing. Integration of assessment, intervention, including group psychotherapy, and management strategies for special and vulnerable populations with mental health problems across the lifespan. Effective Spring 2020</td>
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<tr>
<td>NUR 956</td>
<td>Clinical Diagnosis &amp; Management IV – Complex and Collaborative Mental Health Care</td>
<td>Fall of every year.</td>
<td>6(2-12)</td>
<td>P: NUR 955</td>
<td>R: Open to graduate students in the College of Nursing. Integrates evidence-based strategies to deliver collaborative mental health care across the wellness/illness continuum with patients across the lifespan. Effective Spring 2020</td>
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<tr>
<td>NUR 957</td>
<td>Clinical Diagnosis &amp; Management V – Clinical Immersion – Psychiatric Mental Health</td>
<td>Spring of every year.</td>
<td>6(2-12)</td>
<td>P: NUR 956</td>
<td>R: Open to graduate students in the College of Nursing. Evidence-based management of chronic stable and complex mental health problems within collaborative practice in complex health systems across the lifespan. Effective Spring 2020</td>
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</table>
COLLEGE OF VETERINARY MEDICINE

VM 826  Creating a Food Safety Culture
Summer of odd years. 3(3-0) RB: Professional or graduate status with knowledge of food safety. 
R: Open to graduate students in the College of Veterinary Medicine or in the Department of Large Animal Clinical Sciences or in the Food Safety Major or approval of college. R: Open to graduate students. Approval of college.
Explores proven, evidence-based ways to change or strengthen the food safety culture of an organization and influence employee behavior.
Request the use of ET-Extension to postpone grading.
The work for the course must be completed and the final grade reported within 2 semesters after the end of the semester of enrollment.
Effective Summer 2017 Effective Summer 2019