Engineering Faculty Document No. 35-22

November 2, 2021

**TO:** The Faculty of the College of Engineering

**FROM:** The Faculty of the Weldon School of Biomedical Engineering

**RE:** Curriculum Change for the B.S. Degree in Biomedical Engineering

The faculty of the Weldon School of Biomedical Engineering has approved the following new changes to the curriculum for the B.S. degree in Biomedical Engineering effective for the students entering the School in the Fall Semester 2022. This action is now submitted to the Engineering Faculty with a recommendation for approval.

The proposed changes are as follows:

A. **Modify existing second-year laboratory courses from 16-week to 8-week format and uncouple them from co-requisite content courses**. – This creates space for larger cohort sizes to accommodate growth of undergraduate class sizes while simultaneously creating greater potential flexibility of curriculum by allowing required lab courses to be taught multiple semesters and potentially summers as need increases.
B. **Combine ME 27000 and BME 20400 into a single new course, BME 21400 Introduction to Biomechanical Analysis, to be offered in Fall of second year; Move BME 20100 to Spring of second year**. – This streamlines the teaching of statics to include the direct application to living systems and decouples the labs from their corresponding courses by offering them in different semesters
C. **Move PHYS 24100/PHYS 27200 to Fall of second year; Create a new Sophomore-level basic circuits lab and lecture course (BME 20700 Bioinstrumentation And Circuit Theory) for Spring of second year, replacing former BME 30500 Bioinstrumentation, Circuit, And Measurement Principles**. – This allows PHYS 24100/27200 to be a prerequisite for an introductory circuit class and lab within the sophomore year, allowing students interested in either Bioelectricity or Bioimaging an earlier foundational course than the previous curriculum. This effectively provides BME students a foundation in all sub-disciplines during their second year.
D. **Create Junior-year "Pathway" selectable 2-course sequences for four identified subdisciplines of BME that coincide with our faculty areas of research excellence: Bioinstrumentation & Bioelectronics (BME 30100 & ECE 30100), Bioimaging (ECE 30100 & BME 36000), Biomechanics/Biomaterials (BME 30400 & BME 31400), and Quantitative Biomedicine (BME 35600 & BME 36600)**. – This moves three courses formerly required by all students into selectable Pathways (BME 30100 Bioelectricity, BME 30400 Transport Fundamentals, and ECE 30100 Signals and Systems); redesigns two senior-level technical selectives (BME 43000 & BME 45600) as Junior-level pathway courses (BME 36000 Introduction to Biomedical Imaging and BME 35600 Mathematical Models & Methods in Physiology, respectively); and creates two new

pathway courses (BME 31400 Experimental Methods in Biomechanics and BME 36600 Foundations of Biomedical Data Science). These identified pathways create a system that allows students to more easily identify and select appropriate Pathway, Life Science, and Technical Engineering Selective courses for their area of interest and aptitude. This also increases the quantitative and computational competency of BME students and corrects a deficit in undergraduate courses in the area of Bioimaging.

E. **Create a new course, BME 38000 BME Professionalization Seminar, for the Fall of third year**. – This allows us to build upon soft skills taught in BME 29000 Frontiers of Biomedical Engineering and further student's career exploration, preparation, and readiness.
F. **Create a new lab course, BME 38900 Junior Experimental Design Lab**. – This replaces a fundamental component of former course BME 30600 Biotransport Lab by teaching experimental design using projects from all four sub-disciplines of BME.
G. **Require all student to complete 2 courses from a selected primary Pathway, and one course from an identified secondary Pathway**. – This allows student to begin focusing on their area of interest and aptitude at the beginning of their third year while maintaining curricular breadth by having student select a supporting pathway of information. This also allows us to more clearly subdivide the long lists of Life Science and Technical Engineering selectives into smaller "recommended" lists for each primary pathway.
H. **Increase elective credits from 3.0 to 5.0**. – This maintains our overall 130 credit requirement.
I. **Increase the Major Requirements credit hours from 41 to 56 credits**. – This allows the inclusion of BIOL 23000, CS 15900/18000, MA 26100/27101, MA 26200/26500+26600, PHYS 24100/27200, and STAT 35000/51100 into the calculation of the BME GPA, better representing the coursework that all BME students must complete successfully.
J. **Decrease the Other Departmental/Program Course Requirements credit hours from 86 to 74; Incorporate the Unrestricted elective credit into this same heading**. This accounts for the removal of courses reallocated into the Major Requirements for the BME GPA calculation, and incorporates the Unrestricted Elective credits to avoid current student confusion about what can count as unrestricted electives.
K. **Increase General Education Electives credits from 18 to 24**. – This allows the inclusion of the 6 General Education credits that are taken during the FYE program, which improves student understanding of how General Education and University Core Curriculum requirements can overlap.

**Reason:** The changes reflect a number of recommendations from multiple sources including the recent 10-year external review, a joint BME/ECE Diversity, Equity, and Inclusion study, our annual advisory board recommendations, and current and former student and faculty feedback. These recommendations include incorporating changes that would increase depth of training in specialized areas of BME, improving student identity, and allowing for earlier focus on a sub-field of BME and easier navigation of course options with the introduction of pathways. Additionally, the expectation for growth of our undergraduate program necessitated some structural changes to our lab courses, thus providing an opportunity to reexamine the entire

undergraduate curriculum. These changes create greater flexibility for students and improved scheduling of elective courses and faculty teaching assignments within the School.

David M. Umulis
Dane A. Miller Head and Professor
Weldon School of Biomedical Engineering

| CURRENT | PROPOSED |
|---|---|
| **Degree Requirements**<br>130 Credits Required | **Degree Requirements**<br>Same |
| **Biomedical Engineering Major Requirements (41 credits)** | **Biomedical Engineering Major Requirements (56 credits)** |
| **Required Courses (41 credits)**<br>These courses are used to calculate the BME GPA:<br><br>BME 20100 - Biomolecules: Structure, Function, And Engineering Applications<br>BME 20500 - Biomolecular And Cellular Systems Laboratory<br>BME 29000 - Frontiers In Biomedical Engineering<br>BME 20400 - Biomechanics Of Hard And Soft Tissues<br>BME 20600 - Biomechanics And Biomaterials Laboratory<br>BME 25600 - Physiological Modeling In Human Health<br>BME 30100 - Bioelectricity<br>BME 30400 - Biomedical Transport Fundamentals<br>BME 30500 - Bioinstrumentation Circuit And Measurement Principles<br>BME 30600 - Biotransport Laboratory<br><br><br><br><br>BME 39000 - Professional Development And Design In Biomedical Engineering<br>BME 48901 - Senior Design Project<br>BME 49000 - Professional Elements Of Design<br><br><br>BME 29500 - Selected Topics In Biomedical Engineering - Thermodynamics In Biol Sys II - Credit Hours: 3.00 ◆ or<br>ME 20000 - Thermodynamics I ◆<br><br>ECE 30100 - Signals And Systems ◆<br>ME 27000 - Basic Mechanics I ◆ | **Required Courses (56 credits)**<br>Same<br><br>Same<br><br>Same<br>**BME 20600 - Biomechanics And Biomaterials Laboratory**<br>**BME 20700 Bioinstrumentation And Circuit Theory**<br>**BME 21400 - Introduction To Biomechanical Analysis**<br>**BME 25600 - Physiological Modeling In Human Health**<br>**BME 29000 - Frontiers In Biomedical Engineering**<br>**BME 38000 Professionalization in BME**<br>**BME 38900 Junior Experimental Design Lab**<br>Same<br><br>Same<br>Same<br>**BME Pathways Selectives (9 credits)**<br><br>Same<br><br>Same<br><br>***Delete***<br>***Delete***<br><br>**BIOL 23000 - Biology Of The Living Cell ◆**<br><br>**CS 15900 - C Programming ◆ or**<br>**CS 18000 - Problem Solving And Object-Oriented Programming ◆**<br><br>**MA 26100 - Multivariate Calculus or**<br>**MA 27101 - Honors Multivariate Calculus** |

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| | **MA 26200 - Linear Algebra And Differential Equations or**<br>**MA 26500 - Linear Algebra**<br>**and**<br>**MA 26600 - Ordinary Differential Equations**<br><br>**PHYS 24100 - Electricity And Optics ◆ or**<br>**PHYS 27200 - Electric And Magnetic Interactions ◆** |
| STAT 35000 - Introduction To Statistics ◆ or<br>STAT 51100 - Statistical Methods ◆ | Same<br>Same |
| **Other Departmental/Program Course Requirements (86 Credits)**<br><br>Click *here* for First-Year Engineering Requirements.<br><br>(If pursuing Bachelor of Science in Biomedical Engineering, CHM 11600 - General Chemistry is required to graduate, but not required to complete the First Year Engineering program.) | **Other Departmental/Program Course Requirements (74 Credits)**<br><br>Same<br><br>(If pursuing Bachelor of Science in Biomedical Engineering, CHM 11600 - General Chemistry ◆ is required to graduate, but not required to complete the First Year Engineering program.) |
| BIOL 23000 - Biology Of The Living Cell ◆<br>CS 15900 - C Programming ◆<br>MA 26100 - Multivariate Calculus<br><br>MA 26200 - Linear Algebra And Differential Equations or<br>MA 26500 - Linear Algebra<br>and<br>MA 26600 - Ordinary Differential Equations<br><br>PHYS 24100 - Electricity And Optics ◆ or<br>PHYS 27200 - Electric And Magnetic Interactions ◆<br><br>Life Science Selectives - Credit Hours: 6.00<br>Technical Engineering Selectives - Credit Hours: 15.00<br>General Education Selectives - Credit Hours: 18.00<br><br>Elective - Credit Hours: 3.00 | ***Delete***<br>***Delete***<br>***Delete***<br><br>***Delete***<br>***Delete***<br><br>***Delete***<br><br>***Delete***<br>***Delete***<br><br>Same<br>Same<br>**General Education Selectives - Credit Hours: 24.00**<br>**Electives - Credit Hours: 5.00** |
| **Biomedical Engineering Supplemental Information**<br><br>*Biomedical Engineering Supplemental Information* | **Biomedical Engineering Supplemental Information**<br>Same |
| **Electives** (3 Credits)<br>Electives - Credit Hours: 3.00 | ***Delete***<br>***Delete*** |

| First Year Engineering Program Requirements: | First Year Engineering Program Requirements: |
|---|---|
| **Fall 1st Year** | **Fall 1st Year** |
| CHM 11500 - General Chemistry ◆ *(FYE Requirement #5)* - Credit Hours: 4.00 | Same |
| ENGR 13100 - Transforming Ideas To Innovation I ◆ (*FYE Requirement #1)* - Credit Hours: 2.00 | Same |
| MA 16100 - Plane Analytic Geometry And Calculus I ◆ *(FYE Requirement #3)* - Credit Hours: 5.00 or | Same |
| MA 16500 - Analytic Geometry And Calculus I ◆ *(FYE Requirement #3)* - Credit Hours: 4.00 | Same |
| Written Communication Selective ◆ *(FYE Requirement #8)*- Credit Hours: 3.00-4.00 (satisfies Written Communication for core) or | Same |
| Oral Communication Selective ◆ *(FYE Requirement #8)*- Credit Hours: 3.00 (satisfies Oral Communication for core) | Same |
| 13-14 Credits | Same |
| **Spring 1st Year** | **Spring 1st Year** |
| ENGR 13200 - Transforming Ideas To Innovation II ◆ *(FYE Requirement #2)*- Credit Hours: 2.00 | Same |
| PHYS 17200 - Modern Mechanics ◆ *(FYE Requirement #6)* - Credit Hours: 4.00 | Same |
| MA 16200 - Plane Analytic Geometry And Calculus II ◆ (FYE Requirement #4) - Credit Hours: 5.00 or | Same |
| MA 16600 - Analytic Geometry And Calculus II ◆ *(FYE Requirement #4)*- Credit Hours: 4.00 | Same |
| Written Communication Selective ◆ *(FYE Requirement #8)*- Credit Hours: 3.00-4.00 (satisfies Written Communication for core) or | Same |
| Oral Communication Selective ◆ *(FYE Requirement #8)*- Credit Hours: 3.00 (satisfies Oral Communication for core) | Same |
| Science Selective ◆ *(FYE Requirement #7)*- Credit Hours: 3.00 | Same |
| 16 Credits | Same |
| **Biomedical Engineering Program Requirements** | **Biomedical Engineering Program Requirements** |
| **Suggested plan of study:** | **Suggested plan of study:** |
| **Fall 2nd Year** | **Fall 2nd Year** |
| BIOL 23000 - Biology Of The Living Cell ◆ | Same |
| BME 20100 - Biomolecules: Structure, Function, And Engineering Applications | **BME 21400 Introduction to Biomechanical Analysis** |
| BME 20500 - Biomolecular And Cellular Systems Laboratory | Same |
| BME 29000 - Frontiers In Biomedical Engineering | Same |
| CS 15900 - C Programming ◆ | Same |
| MA 26100 - Multivariate Calculus | Same |

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| ME 27000 - Basic Mechanics I ◆<br><br><br>18 Credits | **PHYS 24100 Electricity and Optics ◆ or PHYS 27200 - Electric And Magnetic Interactions ◆**<br>Same |
| **Spring 2nd Year**<br>BME 20400 - Biomechanics Of Hard And Soft Tissues<br><br>BME 20600 - Biomechanics And Biomaterials Laboratory<br><br><br>BME 25600 - Physiological Modeling In Human Health<br><br>BME 29500 - Selected Topics In Biomedical Engineering - Thermodynamics In Biol Sys II - Credit hours: 3.00 ◆ or<br>ME 20000 - Thermodynamics I ◆<br><br>MA 26200 - Linear Algebra And Differential Equations or<br>MA 26500 - Linear Algebra<br>and<br>MA 26600 - Ordinary Differential Equations<br><br>PHYS 24100 - Electricity And Optics ◆ or<br>PHYS 27200 - Electric And Magnetic Interactions ◆<br>17 Credits | **Spring 2nd Year**<br>**BME 20100 - Biomolecules: Structure, Function, And Engineering Applications**<br>Same<br>**BME 20700 Bioinstrumentation And Circuit Theory**<br>Same<br><br>Same<br><br>Same<br><br>Same<br>Same<br>and<br>Same<br><br>***Delete***<br>***Delete***<br>Same |
| **Fall 3rd Year**<br>BME 30100 - Bioelectricity<br>BME 30500 - Bioinstrumentation Circuit And Measurement Principles<br>BME 30400 - Biomedical Transport Fundamentals<br><br><br>STAT 35000 - Introduction To Statistics ◆ or<br>STAT 51100 - Statistical Methods ◆ (preferred for BME)<br><br><br><br>General Education or Ethics and Policy Healthcare Selective - Credit Hours: 3.00<br>15 Credits | **Fall 3rd Year**<br>**BME 38000 Professionalization in BME**<br>**Primary Pathway Selective - Credit Hours: 3.00**<br>**Secondary Pathway Selective - Credit Hours: 3.00**<br><br>Same<br>Same<br><br>**Technical Engineering Selective - Credit Hours: 3.00**<br>Same<br><br>**16 Credits** |
| **Spring 3rd Year**<br>BME 30600 - Biotransport Laboratory<br><br>BME 39000 - Professional Development And Design In Biomedical Engineering<br>ECE 30100 - Signals And Systems ◆<br><br>Technical Engineering Selective - Credit Hours: 3.00<br>Technical Engineering Selective (Quantitative Breadth/Data Science) - Credit Hours: 3.00 | **Spring 3rd Year**<br>**BME 38900 Junior Experimental Design Lab**<br>Same<br><br>**Primary Pathway Selective - Credit Hours: 3.00**<br>***Delete***<br>**Technical Engineering Selective (Quantitative Breadth) - Credit Hours: 3.00** |

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| General Education or Ethics and Policy Healthcare Selective - Credit Hours: 3.00<br><br><br>16 Credits | Same<br>**General Education Selective - Credit Hours: 3.00**<br>Same |
| **Fall 4th Year**<br>BME 48901 - Senior Design Project<br>BME 49000 - Professional Elements Of Design<br>Technical Engineering Selective - Credit Hours: 3.00<br>Life Science Selective - Credit Hours: 3.00<br>General Education Selective - Credit Hours: 3.00<br>General Education Selective - Credit Hours: 3.00<br>16 Credits | **Fall 4th Year**<br>Same<br>Same<br>Same<br>Same<br>Same<br>Same<br>Same |
| **Spring 4th Year**<br>Technical Engineering Selective (Quantitative Breadth/Data Science) - Credit Hours: 3.00<br>Technical Engineering Selective - Credit Hours: 3.00<br>Life Science Selective - Credit Hours: 3.00<br>General Education Selective - Credit Hours: 3.00<br>General Education Selective - Credit Hours: 3.00<br>Unrestricted Elective - Credit Hours: 3.00<br>18 Credits | **Spring 4th Year**<br>Same<br><br>Same<br>Same<br>Same<br>***Delete***<br>**Unrestricted Elective - Credit Hours: 5.00**<br>**17 Credits** |
| **Notes**<br><br>All required First Year Engineering (FYE) courses must be completed with a C- or above for entry into BME.<br>A minimum Graduation Index and BME Major GPA of at least 2.0 is required to qualify for graduation with a BSBME. | **Notes**<br><br>Same<br><br>Same |
| **Critical Course**<br>The ♦course is considered critical.<br>In alignment with the Degree Map Guidance for Indiana's Public Colleges and Universities, published by the Commission for Higher Education (pursuant to HEA 1348-2013), a Critical Course is identified as "one that a student must be able to pass to persist and succeed in a particular major. Students who want to be nurses, for example, should know that they are expected to be proficient in courses like biology in order to be successful. These would be identified by the institutions for each degree program". | **Critical Course**<br>Same<br>Same |

## Biomedical Engineering Supplemental Information

| CURRENT | PROPOSED |
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| **Biomedical Engineering Supplemental Information** | **Biomedical Engineering Supplemental Information** |
| **Biomedical Engineering Selectives**<br>Below are the lists of courses approved to fulfill the following requirements in the Biomedical Engineering BS program: | **Biomedical Engineering Selectives**<br>Same |

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| Life Science Requirements (6 credits)<br>Technical Engineering Requirements (15 credits)<br>General Education Requirements (18 credits) | **BME Pathway Requirements (9 credits)**<br>Same<br>Same<br>**General Education Requirements (24 credits)** |
| | **BME Pathway Selectives (9 Credits)**<br><br>**Students are required to complete both courses from a selected primary pathway, and one course from a selected secondary pathway.** |
| | **BME Pathway Selective List** |
| | **Bioinstrumentation & Bioelectronics**<br><br>**BME 30100 Bioelectricity**<br>**ECE 30100 Signals & Systems** |
| | **Bioimaging**<br><br>**ECE 30100 Signals & Systems**<br>**BME 36000 Introduction to Biomedical Imaging** |
| | **Biomechanics/Biomaterials**<br><br>**BME 30400 Biomedical Transport Fundamentals**<br>**BME 31400 Experimental Methods in Biomechanics** |
| | **Computational Biomedicine**<br><br>**BME 35600 Mathematical Models & Methods in Physiology**<br>**BME 36600 Foundations of Biomedical Data Science** |
| **Life Science Selectives (6 credits)**<br><br>Below are the courses approved by the BME Curriculum Committee. Any student can petition to get a course added to this list by completing and submitting the Course Approval Request Form (available on the BME website).<br><br>Please access myPurdue to confirm the semester courses are offered. They can change due to instructor availability and course offering rotation. In some cases an override may have to be requested. | **Life Science Selectives (6 credits)**<br><br>Same<br><br>Same |
| **Life Science Selective List**<br><br>At least 6 credit hours must be established from the following areas: Biophysics/Biochemistry, | **Life Science Selective List**<br><br>Same |

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| Cellular/Developmental/Neurobiology, Microbiology, Molecular, Physiology<br><br>Only one HK course may be used to complete the Life Science Selective requirements.<br><br>Please check myPurdue for course availability and pre-requisites. In some cases instructor permission and/or a departmental override might have to be requested. | <br><br>**Only one PUBH course may be used to complete the Life Science Selective requirements.**<br><br>Same |
| **Biophysical and Biochemistry**<br><br>BCHM 30700 - Biochemistry<br>BCHM 56100 - General Biochemistry I<br>BCHM 56200 - General Biochemistry II<br>BIOL 47800 - Introduction to Bioinformatics<br>BIOL 51100 - Introduction To X-Ray Crystallography<br>BIOL 59500 - Special Assignments<br>• Meth Meas Biophys Chem - Credit Hours: 3.00 | **Biophysical and Biochemistry**<br><br>Same<br>Same<br>Same<br>Same<br>Same<br>Same<br>Same |
| **Cell, Developmental, and Neurobiology**<br><br>BIOL 42000 - Eukaryotic Cell Biology<br>BIOL 43600 - Neurobiology<br>BIOL 53800 - Molecular, Cellular, And Developmental Neurobiology<br>BIOL 56200 - Neural Systems | **Cell, Developmental, and Neurobiology**<br><br>Same<br>Same<br>Same<br><br>Same<br>**BIOL 59500 - Special Assignments**<br>**• Neurobiol Learning & Memory** |
| **Microbiology**<br><br>BIOL 43800 - General Microbiology<br>BIOL 53300 - Medical Microbiology<br>BIOL 59500 - Special Assignments<br>• Neurobiol Learning & Memory | **Microbiology**<br><br>Same<br>Same<br>***Delete***<br>***Delete*** |
| **Molecular Biology**<br><br>AGRY 32000 - Genetics<br>BIOL 24100 - Biology IV: Genetics And Molecular Biology<br>BIOL 41500 - Introduction To Molecular Biology<br>BIOL 41600 - Viruses And Viral Disease<br>BIOL 44400 - Human Genetics<br>BIOL 51600 - Molecular Biology Of Cancer<br>BIOL 51700 - Molecular Biology: Proteins | **Molecular Biology**<br><br>Same<br>Same<br>Same<br>Same<br>Same<br>Same<br>Same |
| **Physiology**<br><br>BIOL 20300 - Human Anatomy And Physiology<br>BIOL 20400 - Human Anatomy And Physiology<br>BIOL 30100 - Human Design: Anatomy And Physiology<br>BIOL 30200 - Human Design: Anatomy And Physiology<br>BIOL 43200 - Reproductive Physiology | **Physiology**<br><br>Same<br>Same<br>***Delete***<br>***Delete***<br>Same |

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| BIOL 53700 - Immunobiology<br>BIOL 55900 - Endocrinology<br>BIOL 59900 - Quantitative Physiology<br>BMS 53400 - Systemic Mammalian Physiology<br>PUBH 40000 - Human Diseases And Disorders<br>PUBH 40500 - Principles Of Epidemiology<br>SLHS 30200 - Hearing Science | Same<br>Same<br>Same<br>Same<br>Same<br>Same<br>Same |
| **Technical Engineering Selectives (15 Credits)**<br><br>Below are the courses approved by the BME Curriculum Committee. Any student can petition to get a course added to this list by completing and submitting the Course Approval Request Form (available on the BME website).<br><br>Please access myPurdue to confirm the semester courses are offered. They can change due to instructor availability and course offering rotation. In some cases an override may have to be requested. | **Technical Engineering Selectives (15 Credits)**<br><br>Same<br><br>Same |
| **BME Technical Engineering Selective Policy:**<br><br>A total of 15 credit hours must be completed with the following requirements and restrictions:<br><br>Two 3-credit hour Quantitative Breadth (QB) courses, one of which must be a Data Science-focused QB course.<br><br>Six credit hours may be at the 300-level.<br><br>At least one 3 credit hour BME course must be taken at the 400-level from the Biomedical Engineering list.<br><br>The 400-level BME Technical Engineering Selective course must be successfully completed with a B or above before any 500-level BME course can be taken. This 400-level tech elective must be a 400-level from the Biomedical Engineering curriculum.<br><br>Only one Regulatory Selective can count toward the Technical Engineering Selective requirement.<br><br>One 3-credit course of the Technical Engineering Selective requirements may be satisfied with any of the following approved mentored experiential learning options (must complete all in the same category):<br>3 credits of EPICS (200-level or higher) | **BME Technical Engineering Selective Policy:**<br><br>Same<br><br>Same<br><br>**A maximum of six credit hours may be taken at the 300-level.**<br><br>Same<br><br>Same<br><br>Same<br><br>Same<br><br>Same |

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| 3 credits of BME Research Scholars Program (BME 39500 Research Scholars I, BME 49500 Research Scholars II, and BME 595 Leadership & Impact in BME) | ***Delete*** |
| 3 credits of BME 49800 research for credit (with research syllabus) | Same |
| Students enrolling in a BME course cross-listed with another department should register for the BME section on myPurdue | Same |
| **Quantitative Breadth Selectives List (6 credits)** | **Quantitative Breadth Selectives List (6 credits)** |
| Choose one course from the Data Science Focused QB course list, and a second one from either QB list. | Same |
| **Data Science Focused Quantitative Breadth Courses: (Must choose at least one)** | **Data Science Focused Quantitative Breadth Courses: (Must choose at least one)** |
| BME 40100 - Mathematical & Computational Analysis Of Complex System Dynamics In Biology, Medicine, & Healthcare | Same |
| BME 44000 - Computational Mechanics In Biomedical Engineering | ***Delete*** |
| BME 45000 - Deep Learning For Medical Imaging | Same |
| BME 50100 - Multivariate Analyses In Biostatistics | Same |
| BME 59500 - Selected Topics In Biomedical Engineering | Same |
| • Complex Systs Theory & Appls | Same |
| CS 31400 - Numerical Methods | Same |
| CS 35500 - Introduction To Cryptography | Same |
| CS 38100 - Introduction To The Analysis Of Algorithms | Same |
| IE 33500 - Operations Research - Optimization | Same |
| IE 33600 - Operations Research - Stochastic Models | Same |
| STAT 51200 - Applied Regression Analysis | Same |
| STAT 51400 - Design Of Experiments | Same |
| **Additional Quantitative Breadth Classes:** | **Additional Quantitative Breadth Classes:** |
| ABE 30100 - Numerical And Computational Modeling In Biological Engineering | Same |
| ABE 45000 - Finite Element Method In Design And Optimization | Same |
| BME 45600 - Mathematical Models And Methods In Physiology | **BME 44000 - Computational Mechanics In Biomedical Engineering** |
| BME 51100 - Biomedical Signal Processing | Same |
| BME 59500 - Selected Topics In Biomedical Engineering - Continuum Models Biomed Engr | Same |
| CHE 45600 - Process Dynamics And Control | Same |
| ECE 30200 - Probabilistic Methods In Electrical And Computer Engineering | Same |
| ECE 31100 - Electric And Magnetic Fields | **ECE 30411 - Electromagnetics I** |
| IE 53300 - Industrial Applications Of Statistics | Same |
| MA 41600 - Probability | Same |
| ME 30000 - Thermodynamics II | Same |

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| ME 30900 - Fluid Mechanics | **ME 30800 - Fluid Mechanics** |
| ME 50900 - Intermediate Fluid Mechanics | Same |
| ME 57700 - Human Motion Kinetics | Same |
| NUCL 57000 - Fuzzy Approaches In Engineering | Same |
| STAT 41600 - Probability | Same |
| **Regulatory Selectives List** | **Regulatory Selectives List** |
| Optional. Only one Regulatory Selective can count toward the Technical Engineering Selectives requirements. | Same |
| BME 49500 - Selected Topics In Biomedical Engineering | Same |
| • Glbl Perspect On Med Tech Dsgn | Same |
| BME 56100 - Preclinical And Clinical Study Design | Same |
| BME 56200 - Regulatory Issues Surrounding Approval Of Biomedical Devices | Same |
| BME 56300 - Quality Systems For Regulatory Compliance | Same |
| **Other Technical Engineering Selectives** | **Other Technical Engineering Selectives** |
| | **AAE 50700 - Principles of Dynamics** |
| ABE 37000 - Biological/Microbial Kinetics And Reaction Engineering | Same |
| ABE 44000 - Cell And Molecular Design Principles | Same |
| BME 41000 - Neural Engineering | Same |
| BME 43000 - Introduction To Bioimaging | ***Delete*** |
| BME 46000 - Cardiovascular Mechanical Support And Devices | Same |
| BME 47000 - Biomolecular Engineering | Same |
| BME 49500 - Selected Topics In Biomedical Engineering | Same |
| • Biomedical Microscopy | Same |
| • Gnd Challenges & Accessibility | Same |
| • Smart Healthcare Eng | Same |
| BME 52100 - Biosensors: Fundamentals And Applications | Same |
| BME 52800 - Measurement And Stimulation Of The Nervous System | Same |
| | **BME 53000 - Medical Imaging and Diagnostic Technologies** |
| BME 54000 - Biomechanics | Same |
| BME 55100 - Tissue Engineering | Same |
| BME 55300 - Biomedical Optics | Same |
| BME 55500 - Magnetic Resonance Imaging Theory | Same |
| BME 55600 - Introduction To Clinical Medicine For Engineering Solutions | Same |
| BME 58100 - Fundamentals Of MEMS And Micro-Integrated Systems | Same |
| BME 58300 - Biomaterials | Same |
| BME 59500 - Selected Topics In Biomedical Engineering | Same |
| | **• Bioelectronics** |
| | **• Biophotonics: Fundamentals** |
| • Biomedical Signal Processing | ***Delete*** |

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| • Cell & Tissue Mechanics | Same |
| • Deep Learning | Same |
| | **• Design Of Mobile Robots** |
| • Electromechanical Robotic Sys | Same |
| • Eng Princ Biomolec Interactns | ***Delete*** |
| | **• Functional MRI Applications** |
| • Functional Neuroimaging | Same |
| • Healthcare Systems Engineering | Same |
| | **• Implantable Medical Devices** |
| | **• Light Tissue Interactions** |
| • Med Img & Diagnostic Tech | Same |
| • Molecular & Cell Mechanics | **• Molecular & Cell Biomechanics** |
| • Musculoskeletal Biol & Mechan | ***Delete*** |
| • Neural Mech Health & Disease | Same |
| • Point Of Care Diagnostics | Same |
| | **• Polymeric Biomaterials** |
| • Principles Of Tissue Engr | Same |
| • Regenerative Biol/Tiss Repair | Same |
| • Surgery & Instrumnt Syst Neuro | ***Delete*** |
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| CHE 34800 - Chemical Reaction Engineering | Same |
| CHE 51700 - Micro/Nanoscale Physical Processes | Same |
| | **CHE 52500 - Biochemical Engineering** |
| CHE 54400 - Structure And Physical Behavior Of Polymer Systems | Same |
| CHE 55700 - Intelligent Systems In Process Engineering | Same |
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| CS 30700 - Software Engineering I | Same |
| CS 33400 - Fundamentals Of Computer Graphics | Same |
| CS 34800 - Information Systems | Same |
| CS 40800 - Software Testing | Same |
| CS 44800 - Introduction To Relational Database Systems | Same |
| CS 47100 - Introduction to Artificial Intelligence | Same |
| | **ECE 30010 - Introduction To Machine Learning And Pattern Recognition** |
| | **ECE 30412 - Electromagnetics II** |
| ECE 30500 - Semiconductor Devices | Same |
| ECE 32100 - Electromechanical Motion Devices | Same |
| ECE 36200 - Microprocessor Systems And Interfacing | Same |
| ECE 36800 - Data Structures | Same |
| ECE 43800 - Digital Signal Processing With Applications | Same |
| ECE 44100 - Distributed Parameter Systems | Same |
| ECE 45300 - Fundamentals Of Nanoelectronics | ***Delete*** |
| ECE 45500 - Integrated Circuit Engineering | Same |
| | **ECE 45600 - Digital Integrated Circuit Analysis And Design** |
| ECE 47300 - Introduction To Artificial Intelligence | Same |
| | **ECE 50653 - Fundamentals Of Nanoelectronics** |

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| | **ECE 51100 - Psychophysics**<br><br>**HSCI 31200 - Radiation Science**<br>**HSCI 59000 - Special Topics**<br>**• Advanced MR Imaging**<br>**• Basics Of MR Spectroscopy** |
| IE 34300 - Engineering Economics | Same |
| IE 38600 - Work Analysis And Design I | Same |
| IE 47200 - Imagine, Model, Make | Same |
| IE 53000 - Quality Control | Same |
| IE 54600 - Economic Decisions In Engineering | Same |
| IE 55800 - Safety Engineering | Same |
| IE 57700 - Human Factors In Engineering | Same |
| IE 59000 - Topics In Industrial Engineering | Same |
| • Assistive Technology Practice | Same |
| • Human Factor & Medical Devices | Same |
| MA 34100 - Foundations Of Analysis | Same |
| ME 35200 - Machine Design I | Same |
| ME 36300 - Principles And Practices Of Manufacturing Processes | Same |
| ME 41300 - Noise Control | Same |
| ME 44400 - Computer-Aided Design And Prototyping | Same |
| | **ME 48900 - Introduction To Finite Element Analysis** |
| ME 50500 - Intermediate Heat Transfer | Same |
| ME 50700 - Laser Processing | Same |
| ME 51300 - Engineering Acoustics | Same |
| ME 51700 - Micro/Nanoscale Physical Processes | Same |
| ME 55600 - Lubrication, Friction & Wear | Same |
| | **ME 55900 - Micromechanics Of Materials**<br>**ME 56200 - Advanced Dynamics**<br>**ME 56900 - Mechanical Behavior Of Materials** |
| ME 58600 - Microprocessors In Electromechanical Systems | Same |
| ME 58800 - Mechatronics - Integrated Design Of Electro-Mechanical Systems | Same |
| | **MSE 33000 - Processing and Properties Of Materials** |
| MSE 38200 - Mechanical Response Of Materials | Same |
| MSE 52700 - Introduction To Biomaterials | Same |
| | **MSE 56200 - Soft Materials** |
| MSE 57600 - Corrosion | Same |
| MSE 59700 - Selected Topics In Materials Engineering | ***Delete*** |
| • Soft Materials | ***Delete*** |

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| NUCL 30000 - Nuclear Structure And Radiation Interactions<br>NUCL 47000 - Fuel Cell Engineering<br>NUCL 59700 - Nuclear Engineering Projects I<br>• Introduction To Bioelectrics<br><br>STAT 51300 - Statistical Quality Control | Same<br>Same<br>Same<br>Same<br><br>Same |
| **General Education (18 Credits)**<br><br>BME Undergraduate students must complete 18 credits of general education. General education courses are non-technical courses that provide a broad education necessary to understand the impact of engineering solutions in a global, economic, environmental and societal context.<br><br>Many courses count for both General Education and University Core Curriculum (UCC) Foundational Learning Outcomes (FLO) but many do not. When choosing courses to fulfill these requirements, students will need to check both the UCC FLO course list and the BME Approved General Education Course List found below.<br><br>The following requirements must be met:<br><br>At least 3 credits must be from the Ethics and Policy Healthcare list which is included as a general education course. See list below.<br><br>At least 6 credits must be taken inside the College of Liberal Arts, the Krannert School of Management and/or the Honors College.<br><br>At least 6 credits of the general education courses must be at the non-introductory level, meaning they are at the 30000-level or higher, or have a required prerequisite in the same department.<br><br>The remaining courses may be taken from any of the following areas. If a student is unsure about a course counting for their general education requirement, see academic advisor BEFORE taking the course. | **General Education (24 Credits)**<br><br>**BME Undergraduate students must complete 24 credits of general education. General education courses are non-technical courses that provide a broad education necessary to understand the impact of engineering solutions in a global, economic, environmental and societal context.**<br><br>Same<br><br>Same<br><br>**At least 12 credits must be taken inside the College of Liberal Arts, the Krannert School of Management and/or the Honors College**.<br><br>Same<br><br>**The remaining courses may be taken from any of the following departments. If a student is unsure about a course counting for their general education requirement, see academic advisor BEFORE taking the course.** |
| **Ethics and Policy Healthcare Requirement (3 Credits)** | **Ethics and Policy Healthcare Requirement (3 Credits)** |

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| BME students must complete at least 3 credits (earning a C- or better) addressing ethical and policy issues in healthcare and medicine. It is important that our students have an awareness of societal, regulatory, policy, and ethical considerations that influence healthcare and medicine. Thus, we require our students to take at least one course that advances their knowledge in this area.<br><br>PHIL 20700 - Ethics For Technology, Engineering, And Design<br>PHIL 27000 - Biomedical Ethics<br>PHIL 28000 - Ethics And Animals<br>SOC 57200 - Comparative Healthcare Systems<br>SOC 57300 - The Human Side Of Medicine<br>SOC 57400 - The Social Organization Of Healthcare<br>MSE 59700 - Selected Topics In Materials Engineering Ethics In Engr Practice<br>PSY 58100 - Neuroethics | Same<br><br>Same<br>Same<br>Same<br>Same<br>Same<br>Same<br>***Delete***<br><br>Same |
| **Liberal Arts/Management/Honors (6 Credits)**<br><br>At least 6 credits must be taken inside the College of Liberal Arts, the Krannert School of Management and/or the Honors College.<br><br>*[an unreasonably long list of courses was provided here]* | **Liberal Arts/Management/Honors (12 Credits)**<br><br>**At least 12 credits must be taken inside the College of Liberal Arts, the Krannert School of Management and/or the Honors College. This includes courses with the following departmental prefixes*.**<br><br>**AAS**<br>**AD**<br>**AMST**<br>**ANTH**<br>**ARAB**<br>**ASAM**<br>**ASL**<br>**CHNS**<br>**CLCS**<br>**CMPL**<br>**COM**<br>**DANC**<br>**ECON**<br>**ENGL**<br>**FR**<br>**GER**<br>**HEBR**<br>**HIST**<br>**HONR**<br>**ITAL**<br>**JPNS**<br>**JWST**<br>**LALS** |

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| | **LATN**<br>**LC**<br>**LING**<br>**MARS**<br>**MGMT**<br>**MUS**<br>**PHIL**<br>**POL**<br>**PTGS**<br>**REL**<br>**RUSS**<br>**SOC**<br>**SPAN**<br>**THTR**<br>**WGSS** |
| **Other General Education Selectives**<br><br>[Another unnecessarily long list of courses was provided here] | **Additional General Education Selectives**<br><br>**An additional 9 credits must be taken from the College of Liberal Arts, the Krannert School of Management, the Honors College, or these following additional departmental prefixes*.**<br><br>**AGEC**<br>**CSR**<br>**EDCI**<br>**EDPS**<br>**EDST**<br>**ENTR**<br>**HDFS**<br>**PSY**<br>**SLHS** |
| | ***The following courses may <u>NOT</u> be used toward the General Education Selectives for the Bachelor of Science in Biomedical Engineering.**<br><br>**AGEC 20200 - Spreadsheet Use In Agricultural Business**<br>**AGEC 29800 - Sophomore Seminar**<br>**AGEC 35200 - Quantitative Techniques For Firm Decision Making**<br>**AGEC 45100 - Applied Econometrics**<br>**ANTH 30600 - Quantitative Methods For Anthropological Research**<br>**ANTH 42800 - Field Methods In Archaeology** |

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| | **ANTH 43800 - Field Methods In Biological Anthropology**<br>**ANTH 49700 - Senior Honors Seminar**<br>**ECON 28000 - Mathematics For Economists**<br>**ECON 37300 - Computational Economics**<br>**ECON 46000 - Econometrics**<br>**ECON 46300 - Advanced Data Analysis And Machine Learning**<br>**EDCI 22200 - Knowing The World Through Mathematics**<br>**EDCI 22500 - Mathematics Education Seminar**<br>**EDCI 36400 - Mathematics In The Elementary School**<br>**EDCI 36401 - Teaching Mathematics In K-2**<br>**EDCI 36402 - Teaching Mathematics In Grades 3-6**<br>**EDCI 36500 - Science In The Elementary School**<br>**EDCI 36501 - Teaching Science Through Design In Grades K-2**<br>**EDCI 36502 - Teaching Science Through Design In Grades 3-6**<br>**EDCI 42100 - The Teaching Of Biology In Secondary Schools**<br>**EDCI 42400 - The Teaching Of Earth And Physical Science In The Secondary Schools**<br>**EDCI 42500 - Teaching Of Secondary Mathematics - Methods I**<br>**EDCI 42600 - Teaching Of Secondary Mathematics - Methods II**<br>**EDCI 42800 - Teaching Science In The Middle And Junior High School**<br>**HDFS 40600 - Mathematics In Preschool And Primary Grades**<br>**HDFS 40900 - Curriculum Applications Of Atypical Development**<br>**MGMT 38800 - Python For Business**<br>**MGMT 47400 - Predictive Analytics**<br>**MGMT 47500 - Machine Learning For Business**<br>**PSY 20100 - Introduction To Statistics In Psychology**<br>**PSY 20200 - Introduction To Quantitative Topics In Psychology**<br>**PSY 20300 - Introduction To Research Methods In Psychology** |

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| | **PSY 30500 - Understanding And Analyzing Psychological Data**<br>**PSY 30600 - Understanding And Analyzing Experiments**<br>**PSY 39000 - Research Experience In Psychology**<br>**SOC 38200 - Introduction To Statistics In Sociology**<br>**SOC 38300 - Introduction To Research Methods In Sociology** |
| | **No-Count List**<br><br>**The following courses cannot be used toward any requirement of the Bachelor of Science in Biomedical Engineering.**<br><br>**Any undistributed credit**<br>**Any class taken as Pass/No Pass**<br>**Any BAND course**<br>**BIOL 11000 - Fundamentals Of Biology I**<br>**BIOL 11100 - Fundamentals Of Biology II**<br>**CHM 11100 - General Chemistry**<br>**DANC 24500 - Practicum Dance Perf**<br>**ENGL 11000 - American Language And Culture For International Students I**<br>**ENGL 11100 - American Language And Culture For International Students II**<br>**MA 15300 - College Algebra**<br>**MA 15800 - Precalculus- Functions And Trigonometry**<br>**PHYS 22000 - General Physics**<br>**PHYS 22100 - General Physics**<br>**STAT 30100 - Elementary Statistical Methods**<br>**THTR 33600 - Rehearsal & Perform II** |
| | **Electives – (5 credits)**<br><br>**Students may use any course not already counting toward other degree requirements towards their elective credits, except courses on the No-Count List.** |