BME Undergraduate Tracking Document

Student: Biomechanics Sample Rev: March 6, 2020

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 13/3 Units | | | | | | | | | | | |  | | 2/3 Units | | | | | | |
| **MATH / BASIC SCIENCE / SUPPLEMENTAL SCIENCE** | | | | | | | | | | | |  | **SOCIAL SCIENCE** | | | | | | | |
| Math | | | | | Biology | | | | Chemistry | | |  | ECON 1110 | | | | | ID 2050 | | |
| (2 Units) | | | | | (2/3 Units; at least one at 2000+) | | | | (2/3 Units) | | |  | [courses](http://www.wpi.edu/academics/ssps/ugrad-courses.html) & ID 2050 (for global IQP) | | | | | | | |
| MA 1021: Calculus I | | | | | BB 2550: Cell Biol. | | | | CH 1010: Chem I | | |  | 6/3 Units | | | | | | | |
| MA 1022: Calculus II | | | | | BB 3102: Physiol. | | | | CH 1020: Chem II | | |  | **HUMANITIES REQ’MENT** | | | | | | | |
| MA 1023: Calculus III | | | | | Physics | | | | Suppl. Science  (1/3 Units; any level)  (BB, PH, CH, FY) | | |  | Hu | | | Hu | | | Hu | |
| MA 1024: Calculus IV | | | | | (2/3 Units) | | | |  | Hu | | | Hu | | | InqSem | |
| MA 2051: Diff. Equat. | | | | | PH 1110: Mechanics | | | |  | Click for [HU Requirement](http://www.wpi.edu/academics/hua/ugrad-requirements.html?/) | | | | | | | |
| MA 2610: Statistics I | | | | | PH 1120: Electricity | | | | PH 2510 AFM | | |  | 3/3 Unit | | | | | | | |
|  | | | | |  | | | | | | |  | **IQP** | | | | | | | |
| **COMPUTER PROGRAMMING** (1/3 Unit) | | | | | | | | | BME1004 | | |  | Away | | | Away | | | Away | |
|  | | | | | |  | |  | | | |  | To find an IQP click [link](https://www.wpi.edu/academics/undergraduate/interactive-qualifying-project) | | | | | | | |
| 1/3 Unit | | | | | |  | | 2/3 Units | | | |  | 3/3 Unit | | | | | | | |
| **PHYSICAL EDUCATION** | | | | | |  | | **FREE ELECTIVES** | | | |  | **MQP** | | | | | | | |
| 1/12 | 1/12 | 1/12 | | 1/12 | |  | | PQP/BME 4300 | | ES 1310 CAD | |  | 1/6 A | | 1/3 B | | | 1/3 C | | 1/6 D |
| 14/3 Units | | | | | | | | | | | | | | | | | | | | | |
| **ENGINEERING** | | | | | | | | | | | | | | | | | | | | | |
| **Distribution requirement**  (or higher level, or equivalent) | | | **Example Courses** | | | | | | | |  | | | | | | | | | | |
| **Solid Mech, Implant Design\*** | | | | **Human Dynamics\*** | | | **Comput. Biomech.\*** | \*Sub-specialties within the Biomechanics Track | | | | | | | | | | |
| These are BME CORE | | | | | | | | | | |
| **Equivalent** | | | | | | | | | | |
| Biomechanics1 | | | BME 2502 | | | | | | | | 1ES2501, ES2502, ES2503, and all BME Biomechanics courses also satisfy this requirement. (Note: You cannot receive distribution credit for BME2511, BME2502, and ES2502)  2ES2001 and all BME Biomaterials courses also satisfy this requirement. (Note: You cannot receive distribution credit for BME2811, BME2001, and ES2001)  3ECE2010, ECE2019, and all BME Bioinstrum. courses also satisfy this requirement. (Note: We do not recommend you take both BME2210 and ECE2010). | | | | | | | | | | |
| Biomaterials2 | | | BME 2001 | | | | | | | |
| Bioinstrumentation3 | | | BME 2210 | | | | | | | |
| BME Analysis | | | BME 2211 –Analysis/Prog | | | | | | | |
| ENGR 2000+ #1 | | | ES 2501 | | | | | | | | **Notes** | | | | | | | | | | |
| ENGR 2000+ #2 | | | ES 2503 Dynamics | | | | | | | | ENGR can be BME (except BME3110), CE, CHE, ECE, RBE, ME, and ES courses *at the 2000-level or above (*except RBE 3100) | | | | | | 1000-level do not counted for credit (but very useful): BME 1001 Intro to BME, ME 1800 Manufact. Sci | | | | |
| Engr & Living Syst Lab | | | BME 3111–Physiol and Eng\* | | | | | | | |
| Engr Design | | | BME 3300 – BME Design | | | | | | | |
| BME Lab #1 (1/6 unit) | | | BME 3505 Biomech: techniques lab | | | | | | | |
| BME Lab #2 (1/6 unit) | | | BME 3506 | | | | | BME 3605 | | BME 3506 | Extra suggested courses: | | | | |
| BME Lab #3 (1/6 unit) | | | BME 3503 Skel Biomech lab | | | | | | | | ES 3004 Fluids | | | | |
| BME Lab #4 (1/6 unit) | | | BME 3014 Signal Processing lab | | | | | | | | ES 3001 Thermo | | | | |
| ENGR 3000+ #1 | | | BME 3610 | | | | | | | BME 36104 | 4ME 3501 | | | | | | ME4606 Biofluids | | | | |
| ENGR 3000+ #2 | | | ME 3506 | | | | | | | |  | | | | | |  | | | | |
| BME 4000 depth #1 | | | BME 4504 Biomechanics | | | | | | | | 4000+ should be in your specialization area | | | | | | | | | | |
| BME 4000+ depth #2 | | | BME 4814 | | | | | BME 450X | | |
|  | | |
| **SELF AUDIT** (check Banner to assure your courses are assigned correctly) | | | | | | | | | | | | | | | | | | | | | |
| * 1/3 units Stats (MA 2610, MA 2611) (y/n)?\_\_\_\_\_\_\_ | | | | | | | | | | | | | | | | | | | | | |
| * 1/3 unit Prog (BME 1004) (y/n)?\_\_\_\_\_\_\_ | | | | | | | | | | | | | | | | | | | | | |
| * 14/3 units Engineering (y/n)?\_\_\_\_\_\_\_ with **at least 9/3 units BME** (y/n)?\_\_\_\_\_\_\_ | | | | | | | | | | | | | | | | | | | | | |
| * 3/3 units ENG 2000+ level (y/n)?\_\_\_\_\_\_\_ (note that one green highlighted row will bin in this category) * 2/3 units ENG 3000+ level (y/n)?\_\_\_\_\_\_\_ | | | | | | | | | | | | | | | | | | | | | |
| * BME Labs (4 x 1/6 unit) (y/n)?\_\_\_\_\_\_\_ * \*Living Systems Lab (BME 3111, OR 1/6 unit BB 2903, BB 3511, BB 3514 AND 1/3 unit BME 3000+) (y/n)?\_\_\_\_\_ * 2/3 units BME 4000+ (y/n)? \_\_\_\_\_\_\_\_ (Note: 1/3 unit **AT** BME 4000 level) * 1/3 unit BME design (BME 3300 or equiv) (y/n)? \_\_\_\_\_\_ * Capstone Design in BME (must be checked off by BME program MQP advisor) (y/n)?\_\_\_\_\_\_\_ | | | | | | | | | | | | | | | | | | | | | |

Note that all required courses above will equal 45/3 Units, i.e., you have an additional 3/3 units free to equal 48/3 in 4 years.

**Biomechanics Specialization**

Biomechanics is a specialization within biomedical engineering that involves the application of engineering mechanics to the study of biological tissues and physiological systems.

**Definition from BMES: Biomechanics** - applies classical mechanics (statics, dynamics, fluids, solids, thermodynamics, and continuum mechanics) to biological or medical problems. It includes the study of motion, material deformation, flow within the body and in devices, and transport of chemical constituents across biological and synthetic media and membranes. Progress in biomechanics has led to the development of the artificial heart and heart valves, artificial joint replacements, as well as a better understanding of the function of the heart and lung, blood vessels and capillaries, and bone, cartilage, intervertebral discs, ligaments and tendons of the musculoskeletal systems. From <<http://www.bmes.org/content.asp?contentid=140>>

**Solid (tissue) Mechanics and implant design sub-specialization**

This area involves stress analysis e.g. calculation of the stresses and deformations within biological tissues and prostheses, and characterization of the mechanical properties of tissues and biomaterials.

A **minor in Materials** adds additional depth in materials concepts e.g., Organic Chem, Atomic Force Microscopy, Materials Processing, and Food Engineering.

A **minor in Mechanical Engineering** adds additional depth in core mechanical concepts e.g., Thermo, Heat, Mechanics of Machines, and basic Manufacturing.

**Sub-specialization specific knowledge and skills:**

|  |  |
| --- | --- |
| • Static and dynamic analysis  • Stress analysis  • Continuum mechanics  • Biomechanics  • Statistics  • Transducers  • Modeling  • Anatomy/physiology  • Mechanical properties of biological materials and synthetic biomaterials  • Organic chemistry (Minor in Materials) | • Programming  • Mechanical testing techniques and analysis  • CAD/3D visualization, CAM, additive manufacturing  • Fatigue  • Material selection  • Composites mechanics  • Fracture mechanics  • Finite Element Analysis (Minor in ME)  • Thermal analysis (Minor in ME)  • Animal models, surgical procedures |

**Potential jobs:**

• Mechanical characterization of implants, tissues, and implant/tissue mechanical interactions

• Design of minimally invasive surgery devices, endoscopes, etc.

• Design of bone fixation devices, screws, plates, etc.

• Design of cartilage/meniscus

• Wound care mechanics, tissue augmentation

• Shoe design and testing

• The effects of mechanical loads on cellular mechanics and physiology: Mechanobiology graduate program

• Functional tissue engineering

• Bioreactor design (nascent industry, but growing)

**Human Dynamics sub-specialization**

This area involves analysis of the human body in motion and the interface of the body and prosthetic devices.

A **minor in Mechanical Engineering** adds additional depth in core mechanical concepts e.g., Statics, Dynamics, and Kinematics.

**Sub-specialization specific knowledge and skills:**

|  |  |
| --- | --- |
| • Static and dynamic analysis  • Stress analysis  • Biomechanics  • Statistics  • Transducers  • Signal analysis  • Thermal analysis | • Modeling  • Animal models  • Anatomy/physiology  • Mechanical testing techniques and analysis  • Programming  • CAD/3D visualization, CAM, additive manufacturing  • Finite Element Analysis |

**Potential jobs:**

• Mechanical characterization of implants, tissues, and implant/tissue mechanical interactions

• Design of minimally invasive surgery devices, endoscopes, etc.

• Human Factors Engineer

• Vehicle Integration Engineer

• Safety Engineer

• Ergonomics Project Engineer

• Shoe design and testing

**Computational Biomechanics sub-specialization**

A **minor in Computer Science** adds additional depth in programming, algorithm development, mathematical modeling, and image analysis.

**Sub-specialization specific knowledge and skills:**

|  |  |
| --- | --- |
| • Static and dynamic analysis  • Stress analysis  • Continuum mechanics  • Biomechanics  • Statistics  • Transducers  • Signal analysis  •Modeling  • Animal models  • Anatomy/physiology  • Surgical procedures | • Mechanical properties of biological materials and  synthetic biomaterials  • Mechanical testing techniques and analysis  • Programming  • CAD/3D visualization, CAM, additive manufacturing  • Finite Element Analysis  • Fatigue  • Material selection  • Composites mechanics  • Fracture mechanics |

**Potential jobs:**

• Research and development, especially in the context of devices that interface with people

• Sensors and systems for injury prevention, rehabilitation, and performance measurement and enhancement

• Prosthetics, orthotics, medical robotics and surgical systems

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Sub-specialization** | **Solid (tissue) Mechanics and implant design** | | **Human Dynamics** | | **Computational Biomechanics** |
| *Minor* | *Mechanical Engineering\** | *Materials\*\** | *Mechanical Engineering\*\*\** | *Computer Science***\*\*\*\*** | |
| Double Count courses | ES 2501 | ES2001 | ES 2501 | CS 1101 | |
| ES 2503 | PH 2510 | ES 2503 | CS 2102 | |
| ES 3001 | BME 4814 | ES 3001 | CS 4032 | |
| Additional courses to fulfill the minor | ME 1800 | ME 2820 | ES 1310 | CS 2223 | |
| ES 3004 | CHE 2310 | ES 3004 | CS 2303 | |
| ME4320 | ME 4821 | ME3310 | CS 4341 | |

**Can double count up to 3/3 units towards minor and major (that means you must take at least an additional 3/3 units for the minor)**

**\*** Extra suggested courses: ES 1310 CAD (not counted for credit), ME 4512 FEM, ME 4606 Biofluids, ME 3506 Rehab Engr

**\*\*** Extra suggested courses: ES 1310 CAD (not counted for credit), ES 3004 Fluids, ES 3001 Thermo, ME4606 Biofluids

\*\*\* Extra suggested courses: ES 3004 Fluids, ES 3003 Heat Transfer (in lieu of 3001), ME 4512 FEM, ME 4606 Biofluids, ME 3501 Continuum (C.II)

\*\*\*\* Extra suggested courses: ME 3703, ME 4322, ECE 2010, MA 2071 (Matrix/lin alg)