BME Undergraduate Tracking Document

Student: Biomedical Sensors, Instrumentation, Imaging Sample Rev: March 26, 2021

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| 13/3 Units |  | 2/3 Units |
| **MATH / BASIC SCIENCE / SUPPLEMENTAL SCIENCE** |  | **SOCIAL SCIENCE** |
| Math | Biology | Chemistry |  | ECON, ENV, GOV | PSY, SD, SOC, SS |
| (2 Units) | (2/3 Units; at least 1/3 unit 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, MA, CS, FY) |  | Hu | Hu | Hu |
| MA 1024: Calculus IV | (2/3 Units) |  | Hu | Hu | Inq Sem |
| 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 1140 Osc & Wave |  | 3/3 Unit |
|  |  |  | **IQP** |
| **COMPUTER PROGRAMMING** (1/3 Unit) | BME 1004 |  | 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 |  |  |  |  | 1/6 A  | 1/3 B | 1/3 C | 1/6 D |
| 14/3 Units |
| **ENGINEERING** |
| **Distribution Req.**(or higher level, or equivalent) | **Example Courses** | \*Sub-specialties within the Bioinstrumentation Track |
| **Sensors & Instrumentation\*** | **Signals\*** | **Imaging\*** | **These are BME Core** |
| **Equivalences** |
| Biomechanics | BME 2502 | - Consult the Biomedical Engineering Program Chart in the Undergraduate catalog for courses that count towards these requirements. - Students that entered Fall 2020 and after: You can only receive ENGR distribution credit for one of BME2502 or ES2502.You can only receive ENGR distribution credit for one of BME2001 or ES2001.- We do not recommend you take both BME2210 and ECE2010. |
| Biomaterials | BME 2001 |
| Bioinstrumentation | BME 2210 |
| BME Analysis | BME 2211 – Biomed Data Analysis |
| ENGR 2000+ | ECE 2019 – Sensors, Circuits, Systems | ECE 2311 – Cont. Signals | **Notes** |
| ENGR 2000+ | ECE 2029 – Intro to Dig. Circuit Design | ECE 2312 – Disc. Signals | ECE 2112 (E & M Fields) | ENGR can be BME (except BME 1001, BME 1004, BME 3110, BME 532, BME 560, BME 562, BME 564, and BME 593; BME 595 requires departmental approval), CE, CHE, ECE, RBE, ME, and ES courses at the 2000-level or above (except RBE 3100).Extra suggested courses:ECE 2201ECE 3204ECE 2799ECE 2049Free Elective:BME 1001 |
| ENGR 2000+ | BME 3111 – Physiology and Engineering |
| Engr Design | BME 3300 – BME Design |
| BME Lab #1 (1/6 unit) | BME 3012 – Biomed. Sensors lab |
| BME Lab #2 (1/6 unit) | BME 3013 – Biomed. Instrumentation lab |
| BME Lab #3 (1/6 unit) | BME 3014 – Biomed Signals lab |
| BME Lab #4 (1/6 unit) | BME 3811 – Biomaterials lab |
| ENGR 3000+ | ECE 3849 – R/T Embedded Systems |
| ENGR 3000+ | ECE 4703 – R/T DSP | ES 3011 – Contr. Eng |
| BME 4000 depth | BME 4023 – Biom. Instr. | BME 4011 – Biomed Signal Analysis |
| BME 4000+ depth | BME 4201 – Biomed Imaging |
|  |
| **SELF AUDIT** (check Banner/WorkDay 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 9/3 units BME (y/n)?\_\_\_\_\_\_\_
 |
| * 3/3 units ENG 2000+ level (y/n)?\_\_\_\_\_\_\_ (note that the green highlighted rows may bin in this category)
* 2/3 units ENG 3000+ level (y/n)?\_\_\_\_\_\_\_
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| * BME Labs (4 x 1/6 unit) (y/n)?\_\_\_\_\_\_\_
* Living Systems Laboratory requirement (BME 3111, BME 3012, BME 3503, or BME 3813) (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)?\_\_\_\_\_\_\_
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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.

**SENSORS AND INSTRUMENTATION Sub-Specialization:** Modern health care relies heavily on a large array of sophisticated medical instrumentation and sensors to diagnose health problems, to monitor patient condition and administer therapeutic treatments, most often in a non-invasive or minimally invasive manner. During the past decade, computers have become an essential part of modern bioinstrumentation, from the microprocessor in a single-purpose wearable instrument used to achieve a variety of small tasks to more sophisticated desktop instruments needed to process the large amount of clinical information acquired from patients. The Biomedical Instrumentation track is focused on training students to design, test, and use sensors and biomedical instrumentation to further enhance the quality of health care. Emphasis is placed both on understanding the physiological systems involved in the generation of the measured variable or affected by therapeutic equipment, as well as the electrical engineering principles of biomedical sensors and biomedical devices.

**Examples of common biomedical instrumentations jobs include:**

• Specialized instrumentation for genetic testing

• Electrocardiography to measure the electrical activity of the heart

• Electroencephalography to measure the electrical activities of the brain

• Electromyography to measure the electrical activities of muscles

• Mechanical respirators

• Cardiac pacemakers

• Defibrillators

• An artificial heart

• Heart-lung machines

• Pulse oximeters

• Drug infusion and insulin pumps

• Electrosurgical equipment

• Anesthesia equipment

• Kidney dialysis machines

• Artificial electronic prosthetics used by disabled people (e.g. hearing aids)

• Laser systems for surgery

**SIGNALS Sub-Specialization:** Biosignal processing involves the collection and analysis of data from patients or experiments to identify and extract distinct components of the data set that may lead to better understanding of the processes involved in physiological regulation. For example, identifying and quantifying differences in the dynamic characteristics of physiological function between normal and diseased conditions utilizing biosignal processing techniques may lead to a better understanding of the role of regulatory imbalance in diseased conditions, and should have important clinical and diagnostic and prognostic application.

**Examples of jobs requiring background in signals include:**

• Detection of abnormal heart rhythms from electrocardiograms

• Monitoring of vital signs

• Seizure detection using electroencephalogram recordings

• Real-time control of artificial prosthetics

• Real-time control of robotic movements

• Detection of hypertension and onset of diabetes

• Wireless transmission of medical diagnostic devices

• Modeling of pharmacokinetics and design of algorithms for robust drug delivery

• Bioinformatics

• Pattern recognition and decision support systems

• Artificial intelligence

**IMAGING Sub-Specialization:** Biomedical Imaging involves the measurement of spatiotemporal information over scales ranging from molecules to organs to whole bodies, spanning the spectrum of optics, ultrasound, X-ray/CT, MRI, and molecular imaging. It is based on mathematics, physics, and the understanding of physico-chemical properties of cells and tissues. Imaging also includes data-intensive computational analysis.

**Examples of jobs requiring background in imaging include:**

• Physics background (Optics, Electromagnetism, Quantum Mechanics)

• Instrumentation

• Computer Programming

• Signal Processing

• Computer Vision

• Artificial intelligence

**Minors have been identified for each sub-specialization to allow for a more distinguished experience.**

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| **Minor** | **ECE\*** | **RBE\*\*** | **CS\*\*\*** |
| Double Count courses  | BME 4011 | 1/3 unit ECE | 1/3 unit CS |
| BME 4023 | 1/3 unit RBE | 1/3 unit CS |
| ECE 2019 | 1/3 unit RBE | *See below* |
| Additional courses to fulfill the minor | ECE 2799 | 1/3 unit CS | *See below* |
| ECE 2029 | 1/3 unit RBE | *See below* |
| ECE 2311 | 1/3 unit ME/ES | *See below* |

**\*Example of 2 units of courses for a possible Minor in Electrical and Computer Engineering (ECE):**

2 units of courses with the prefix “ECE” at the 2000-level or above. Of the 2 units, at least 2/3 unit must be from ECE courses at the 3000-level or above which are thematically related.

**\*\*Example of 2 units of courses for a possible Minor in Robotics Engineering (RBE):**

1/3 unit CS selected from CS 2102, CS 2223, CS 2301, CS 2303, CS 3733

1/3 unit ECE selected from ECE 2010, ECE 2019, ECE 2029, ECE 2049, ECE 2311

1/3 unit ME/ES selected from ES 2501, ES 2503, ES 3011, ME 3310

2/3 units from RBE 1001, RBE 2001, RBE 2002

1/3 unit capstone experience through an RBE course at 3000-level or above

**\*\*\*Example of 2 units of courses for a possible Minor in Computer Science (CS):**

• No more than one course at the 1000-level

• The 2 units must include one of the following, each of which provides an integrating capstone experience

* Any CS 3000-level course, except for CS 3043
* Any CS 4000-level course, except for CS 4032 and CS 4033
* Any graduate-level computer science course, except for CS 505
* 1/3 unit of another activity, for example an ISU, which is validated by the CS faculty instructor as a capstone