**TO:** The Engineering Faculty

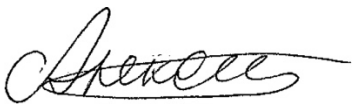
**FROM:** The Undergraduate Advisory Council

**RE:** BS in Integrated Business and Engineering

The Faculty of The Undergraduate Advisory Council has approved the following new Baccalaureate program to be offered by the Krannert School of Management in partnership with the College of Engineering. This action is now submitted to the Engineering Faculty with a recommendation for approval.

**Description**: BS in Integrated Business and Engineering

**Reason:** Please see attached document which provides all necessary information regarding the BS in Integrated Business and Engineering.



***Alina Alexeenko***

Chair of Committee

**March 25, 2020**

# BSIM 2.0: A Proposal to Revamp Bachelor of Science in Industrial Management (BSIM)

## BS in Integrated Business and Engineering


Committee Members
Tom Brush (BUS)
Suresh Chand (BUS)
Dilip Chhajed (Chair, BUS)
Roy Dejoie (BUS)
James Jones (ENG)
Matthew Lynall (BUS)
Ben McCartney (BUS)
Mary Pilotte (ENG)
Kelly Wilson (BUS)
Carla Zoltowski (ENG)

Sarah Vaughn (Administrative Support)

**Proposal to Revamp Bachelor of Science in Industrial Management (BSIM)**

## BACKGROUND

The first Bachelor of Science in Industrial Management (BSIM) degrees were awarded to 80 students in 1961. One student who transferred into Krannert after starting an Engineering program described his BSIM program this way: "A typical engineering student would have to finish their undergraduate program, work as an engineer for a few years and then go back to school for a business degree in order to get that technical management opportunity that I am pursuing. With the Industrial Management degree from Krannert, I will be able to essentially combine all those steps into one four-year undergraduate experience." This analytically focused business degree has produced many highly successful graduates, but has not been updated for several years. This proposal is for revising the curriculum of the BSIM program and introduce it as a new major, based on feedback from many different stakeholders, including current and former students, academic advisors, and employers.

This new major will concretely integrate the engineering design and decision-making knowledge base with the management knowledge base to provide a comprehensive learning experience. This will be accomplished by engaging students with an interdisciplinary approach to think critically, develop insights, identify issues and bias, tolerate ambiguity, and recognize and appreciate ethical concerns are central to the new program. Students will have the opportunity to work on hands-on and on-site experiences to become more engaged and ensure the learnings are real and relevant More generally, the new program will promote the importance of interdisciplinary thinking by building bridges between engineering and management.

We propose to introduce "Integrated Business and Engineering" as a new major within the Bachelor of Science in Management . Herinafter, we will refer to the new program as IBE.

## WHY AN ENGINEERING AND MANAGEMENT PROGRAM?

### National Competitiveness

Several national reports have called for growth in student enrollment in STEM fields to increase national competitiveness (Holmlund, Lesseig, & Slavit, 2018). In addition to government spending in STEM programs, industry leaders have created comparable investments to produce similar benefits that intend to provide favorable results in STEM education programs (Kuenzi, 2008). The demand for STEM talent has continued to grow, typically outstripping supply. The American Association for the Advancement of Science (1993) advised that the security and future of America be dependent upon informed individuals who are capable of reasoning and thinking creatively, to make decisions, to solve problems in an everyday context. It is vital to open up pathways to careers that call for a dual understanding of both business and engineering.

### Advancements in Business and Technology

In parallel, rapid technological progress is enabling substantial changes in business. Ubiquitous access to information through networked devices, enabled by ever-shrinking electronics and expanding means of rapid data transfer have created new opportunities to understand and manipulate our environments productively. This

is leading to an increasingly complex technological landscape integrating hardware, software, and biological systems (Klaus, 2016). Harnessing and maximizing the potential of integrated technologies to create new and improve current businesses will be a critical requirement of the next generation of university graduates. By systematically creating an opportunity to think through engineering and business issues, this program will create the leaders who can take on the challenges of a complex world.

Many of those currently working at the interface of leveraging technology to create new enterprises have learned on the fly through the entrepreneurial process, often in fits-and-starts, through embarrassing failures, and trial-and-error. At the same time, as technology has advanced, there are vast unexplored opportunities due to a lack of trained professionals who can understand and harness the potential of technological advances while creating viable businesses. These developments have provided guidelines for what the program should change to.

**Stakeholder Input**

With the above in mind, we engaged Purdue's M&M and an outside company, Ologie, to understand the perception and issues with the current BSIM program. The teams conducted a study that included analysis of admission data; mining of social media postings; focus groups with Enrolment Managements High School Guidance Counselor Advisory Board; peer school benchmarking; and in depth interviews with current and former students, advisors, employers, regional recruiters, internal stakeholders, and members of the Board of Trustees. The major findings from this study are as follows:

***Perceptions***

- Those aware of the IM degree have positive perceptions of its students, specifically their problem solving skills
    - However, there is little awareness of the IM degree both internally and externally.
- The IM degree's primary point of differentiation is that it offers a blend of technology and advanced math with business, suggesting flexibility and rigor.
- IM students and alumni believe their rigorous coursework warrants distinction.
    - However, they feel the school no longer adequately supports the program, particularly without a dedicated champion.

***Peer Audit***

- Peers confidently talk about what their degree is, who it's for, and why it matters.
- They speak to the prospective student and dial in on their interests, communicating why that degree is a good fit
- The main ideas they communicate:
    - Interdisciplinary
    - Multiple career paths
    - Business leadership
    - Entrepreneurial mindset
    - Pairing quantitative expertise with an aptitude/interest in business

***Recommendations***

As a result of the study. The following recommendations were made by the study team:

1. IBE should be a marriage of business and technology engineered for the future, not the past

2. IBE, as an undergraduate degree, can be differentiated from comparable programs, which are typically for graduate and professional students, and programs at peer institutions that lack a similar degree.
3. IBE needs to be reframed from the perception that the current BSIM is for students who (as reported in students interviews) can't cut it in engineering.
4. IBE needs a dedicated champion, empowered and motivated to completely recharge the program.
5. "Engineering and Management" more clearly reflects what students and employers are looking for today, which "Industrial Management" (despite alumni nostalgia) does not.
6. IBE should be a joint degree with the College of Engineering for the very best of the best.

**IBE PROGRAM OVERVIEW**

The proposed interdisciplinary major is focused on developing students with skills and knowledge to rapidly progress to leadership roles and be able to function effectively in complex, dynamic, and technology-driven organizations and entreprises - both new and established - that embrace technological progress for economic and social benefit.

Offered under a partnership between the Krannert School of Management and the College of Engineering, this innovative program will provide a firm grounding in both management and engineering, with specialization options in interdisciplinary management areas relevant to contemporary business environments. The program will combine the science of new technologies and the business opportunities created by them. The IBE curriculum will allow students to connect interests in a way that creates multiple career pathways within technologies and organizations. Students graduating with this degree will be able to adjust to changing environments, spur creativity, lead teams, master communication skills, and evaluate/interpret data.

The IBE curriculum is based on a holistic, integrative, and strategic systems view at multiple levels (individual, group, and organization) through diverse coursework, interdisciplinary seminars, customized labs, engagement with activie research projects, and culminates in an industry-driven capstone design course consisting of a project that amplifies the importance of collaboration amongst diverse stakeholders, strategic product/service development, and tactical product/service realization.

Key components of the IBE are:

- Core coursework with additional electives in management, engineering, and mathematics thereby providing strong interdisciplinary foundation for students. to select from a variety of structured and customized study plans. The core business courses provide breadth of functional areas of business and the electives add depth in selected areas. Further specialization is possible and many options can earn students transcriptable concentrations. Engineering courses will include the first year engineering curriculum, which is the launchpad for all engineering students at Purdue, and an engineering minor (currently in development within the College of Engineering).
- Engineering Projects in Community Service (EPICS), in which teams of students partner with local and global community organizations to address human, community, and environmental needs.

- Vertically Integrated Projects (VIP), in which students are engaged in authentic and extended research and design projects related to active research areas of Purdue faculty members and national, international, and industry-sponsored design challenges.
- Seminar courses to expose students to contemporary topics related to the design and management of socially responsible modern organizations and enterprises. These seminars will leverage the expertise of faculty across Purdue, prominent alumni, and thought leaders in each (flexible, rotating) topic area. Seminar topics might include, for example, artificial intelligence, cybersecurity, climate resilience, and sustainable economic growth.
- Strong team and project experiences to build a comprehensive interdisciplinary, analytically focused problem-solving toolkit suitable for tomorrow's industry or advanced education. The capstone experience in Year 4 will likely involve interdisciplinary team-based projects sponsored by companies advising and recruiting from IBE.

## IBE PROGRAM DESCRIPTION

### Goal and Objectives

The goal of the program is to prepare future technology leaders. Students will be able to:

- Make decisions in an uncertain environment.
- Have the ability to innovate: design new and complex products and processes; improve methods, procedures, processes, and policies.
- Solve new and complex multidisciplinary problems arising in technology driven enterprises to service organization issues faced by society.
- Coordinate, synthesize, and integrate technology solutions.
- Leverage existing and upcoming technologies.

### Curriculum

The curriculum is designed with the above goals in mind. The main elements of the curriculum are presented in figure 1.


* Teece et al. (1997) define dynamic capabilities as "the ability to integrate, build, and reconfigure internal and external competencies to address rapidly-changing environments."

Figure 1: Curriculum Elements

**Learning Outcomes**

The learning outcomes for each curriculum element are described below:

*Mathematics*

Knowledge of problem-solving skills in a broad range of mathematics; ability to produce and judge the validity of rigorous mathematical arguments; ability to communicate mathematical ideas and arguments, both written and orally; and prepared to use mathematics in their careers.

*Business*

Knowledge of current information, theories and models, and techniques and practices in all of the major management disciplines, including the general areas of accounting, finance, management information systems, marketing, organizational behavior and human resource management, strategic management, and supply chain and operations management.

*Engineering*

Common knowledge base in physics, chemistry, and engineering topics such as data visualization and analysis, ethics, engineering design, application of basic programming to the solution of engineering problems, development of mathematical models to solve engineering problems, teamwork skills, and professional communications.

*Systems Thinking*

Ability or skill to perform problem solving in complex systems including an understanding of basic interactions among the elements of a system; the difference between open and closed

systems; development of a habitual anticipation that a perturbation in one element of a system may have effects throughout the whole system; and the ability to identify multiple causal factors that could influence a single observation or outcome.

*Specialty Area*

Learning outcomes specific to an area of specialization that students may select in either the engineering or management disciplines with a selection of elective courses to develop greater in-depth knowledge and skills in that area.

*Data Analytics*

Development of relevant programming abilities; proficiency with statistical analysis of data; ability to build and assess data-based models; ability to execute statistical analyses with professional statistical software, skill in data management; application of data science concepts to solve problems in real-world contexts and ability to communicate these solutions effectively.

*Leadership, Team and Communication Skills*

Discovery, development, and practice of skills required to enable a diverse team to address complex problems affecting a wide range of stakeholder through collaboration, communication, and application of a wide range of influencing strategies and techniques.

*Hands on Experience*

Development and internalization of skills and knowledge acquired from coursework through participation in consulting, technology commercialization, research and design, study abroad, and global and local community development projects.

*Interdisciplinary*

Students have the opportunity to structure a plan of study that draws on courses and learning experiences not offered within the School of Management and College of Engineering. For example, a student may wish to gain a deeper understanding of the cultural and social aspects of grand challenges such as education, energy, the environment, food, and health for which there are relevant course across Purdue's academic units.

**Coursework**

Business Courses: The program has minimum 46 credit hours of business courses that include core courses in the management disciplines with specialization options in interdisciplinary management areas relevant to contemporary and technology-driven business organizations.

Engineering Courses: The program has minimum 20 credit hours of coursesfrom college of egnineering that include the first-year engineering model (see Figure 5). The Engineering minor (this is a working name), when approved, will be a required part of the program and the curriculum includes the required course work. Engineering courses include two courses in different engineering departments and one engineering expansion course to either add depth in one area of engineering or provide breadth in a third area of engineering.

Experiential Courses: The curriculum has at least 9 credit hours of coursework devoted to hands on experience. These courses

1. Focus on Innovation. Innovation includes,
    a. Design of a new product or service, e.g. designing a new umbrella
    b. Problem solving, e.g. how to encourage diabetes patients to eat healthy food
    c. Improvement, e.g. how to reduce the time it takes to process a loan application
2. Interdisciplinary
3. Progressive and building on top of the other (progressive in disciplinary knowledge used, complexity of problems, and comprehensiveness of analysis)
4. Helps in integrating and applying coursework, although not limited by them
5. Practice teamwork, leadership, and communication
6. Can include Purdue Study Abroad programs

The curriculum is shown in figure 2, and the courses in each of the curriculum elements described above are shown in figure 3. An example student schedule is described in figure 4.

Student Experience: The program will provide an excellent student experience. Small class sizes, limited to one cohort of about 50 students will allow for highly customized student engagement and will create a sense of belonging. The following design elements are included in the program:

1. Cohort structure – The program will have several courses and other classroom experiences that the students will experience as a cohort.
2. Selective admission – For effective cohort experience, the class size will be limited to one section.
3. Specialty organized professional development activities focusing on developing leaderships, team building, and communication skills.
4. Learning community –A IBE learning community will help students form fellowship outside of the class room.

| Business Courses | | |
|---|---|---|
| **Business Core Courses** | CR | 37 |
| Introduction to Accounting (MGMT 20000) | 3 | |
| Management Accounting (MGMT 20100) | 3 | |
| Microeconomics (ECON 25100)*UCC-BSS | 3 | |
| Program for Business Apps (MGMT 28800) | 3 | |
| Intellect Property Management (MGMT *****) | 2 | |
| Business Statistics (MGMT 30500)* | 3 | |
| Financial Management (MGMT 31000)* | 3 | |
| Marketing Management (MGMT 32400) | 3 | |
| Strategic Management (MGMT 35200) | 3 | |
| Operations Management (MGMT 36100)* | 3 | |
| Management Info Systems (MGMT 38200)* | 3 | |
| Organizational Behavior (OBHR 3300) | 3 | |
| Storytelling with Data (MGMT *****) | 2 | |
| | | |
| **Business Method Electives** | | 6 |
| Management Science (MGMT 30600) | 3 | |
| Project Management (MGMT 46600) | 3 | |
| Spreadsheet Modeling (MGMT 47200) | 3 | |
| Predictive Analytics (MGMT 47400) | 3 | |
| | | |
| | | |
| **Business Depth Course** | | 3 |
| Managerial Economics (ECON 30100) | 3 | |
| Intermediate Financial Accounting (MGMT 35300) | 3 | |
| Investments (MGMT 41100) | 3 | |
| Digital Marketing Strategy (MGMT 42710) | 3 | |
| Leadership & Org Change (MGMT 44362) | 3 | |
| Technology Strategy (MGMT 44810) | 3 | |
| Supply Chain Analytics (MGMT 46300) | 3 | |
| Data Mining (MGMT 47300) | 3 | |
| Data Driven Decisions in Dig Mrkt (MGMT 48800) | 3 | |
| **Total Credits: 120-121** | | |

| Engineering Courses | | |
|---|---|---|
| **Engineering Core Courses** | CR | 23 |
| General Chemistry (CHM 11500) UCC-SCI | 4 | |
| Analytical Geometry & Calc I (MA 16500) UCC-QR | 4 | |
| Analytical Geometry & Calc II (MA 16600) UCC-QR | 4 | |
| Transform Ideas into Innovation & EPICS or VIP (ENGR 13300) | 2 | |
| Modern Mechanics (PHYS 17200) UCC-SCI | 4 | |
| First-Year Participation in EPICS/VIP I (EPCS 11100 or ENGR 17911), UCC-STS?? | 1 | |
| First-Year Participation in EPICS/VIP II (EPCS 12100 or ENGR 17912), UCC_STS ?? | 1 | |
| Engineering Expansion Course ^ | 3 | |
| *^(Any Engineering course except a junior or senior required seminar)* | | |
| **Engineering IBE Core** | | **6** |
| (2) Engineering IBE Core courses - See List in Figure 5 | 6 | |
| **Engineering Electives** | | **3** |
| It's a Complex World: Address GC (SYS 30000)* UCC-STS | 3 | |
| Systems Theories & Approaches (SYS 35000)* UCC-STS | 3 | |
| Imagine, Model, Make (IE 47200) | 3 | |
| **Seminar & Innovation Labs** | | 11 |
| IBE Seminar (MGMT *****)- 1.0 X 4 | 4 | |
| *Team-based design in EPICS or VIP*: EPCS 20100, 20200, 30100, 30200 or ENGR 27920, 37920 | 4 | |
| IBE Capstone | 3 | |
| **Other Course Requirements** | | 16-17 |
| Written Communication UCC-WC & UCC-IL | 3-4 | |
| Oral Communication UCC-OC | 3 | |
| Human Cultures: Humanities UCC-HUM | 3 | |
| Multivariate Calculus (MA 26100) UCC-QR | 4 | |
| Probability & Statistics for Business (STAT 30300) | 3 | |
| | | |
| **Specialty Areas** | | 12 |
| Financial Engineering, Supply Chain Operations Management, Data Analytics | | |
| Student Designed Area (with advisor approval) | | |
| **Electives** | | 3 |
| General Elective | 3 | |
| | | |

^additional courses may be added to the list of electives after consultation with the relevant committees

&The Engineering Expansion Course list will be developed by the COE and may not include the professional development seminar courses.

Several business core courses as well as engineering courses will have separate sections for the BSIM 2.0 students who will move through the program as a cohort.

Figure 2: IBE Curriculum


Figure 3: Curriculum Elements with Courses

| | | | | | |
|---|---|---|---|---|---|
| YR 1 | | Fall Semester | | | Spring Semester |
| | 4 | General Chemistry (CHM 11500) | | 1 | EPICS or VIP (EPCS 12100 OR ENGR 17912) |
| | 2 | Transform Ideas into Innovat EPICS (ENGR 13300) | | 4 | Analytics Geo & Calc II (MA16600) |
| | 4 | Analytic Geo & Calc I (MA 16500) | | 4 | Modern Mechanics (PHYS 17200) |
| | 3 | Intro to Accounting (MGMT 20000) | | 3 | Microeconomics (ECON 25100) |
| | 1 | EPICS or VIP (EPCS 11100 OR ENGR 17911) | | 3 | Oral Communication |
| | 1 | IBE Seminar: Intro to Business (MGMT *****) | | 3 | UCC Human Cultures; Humanities |
| | 15 | Total | | 18 | Total |
| | | | | | |
| YR 2 | | Fall Semester | | | Spring Semester |
| | 3 | Management Accounting (MGMT 20100) | | 3 | Business Statistics (MGMT 30500) |
| | 3 | Marketing Management (MGMT 32400) | | 3 | Financial Management (MGMT 31000) |
| | 3-4 | Written Communication | | 3 | Programming for Business Apps (MGMT 28800) |
| | 3 | Engineering IBE Core Course | | 3 | Engineering IBE Core Course |
| | 3 | Probability & Statistics in Business (STAT 30300) | | 3 | Business Method Elective |
| | 1 | IBE #2 Seminar: TBD (MGMT *****) | | 1 | IBE #3 Seminar: TBD (MGMT *****) |
| | | | | | |
| | 16-17 | Total | | 16 | Total |
| | | | | | |
| YR 3 | | Fall Semester | | | Spring Semester |
| | 4 | Multivariate Calculus (MA 26100) | | 3 | Engineering Expansion Course |
| | 3 | Engineering Elective | | 3 | Area Specialty Course |
| | 3 | Business Method Elective | | 3 | Operations Management (MGMT 36100) |
| | 2 | Intellectual Prop Management (MGMT *****) | | 3 | Management Info Systems (MGMT 38200) |
| | 3 | Area Specialty Course | | 2 | IBE Innovation Lab: VIP |
| | 2 | IBE Innovation Lab: VIP | | | |
| | | | | | |
| | | | | | |
| | 17 | Total | | 14 | Total |
| | | | | | |
| YR 4 | | Fall Semester | | | Spring Semester |
| | 2 | Storytelling with Data (MGMT *****) | | 3 | Business Depth Course |
| | 3 | Strategic Management (MGMT 35200) | | 3 | Area Specialty Course |
| | 3 | Intro to Organizational Behavior (OBHR 33000) | | 3 | Area Specialty Course |
| | 3 | General Elective | | 3 | Capstone Project |
| | 1 | IBE #4 Seminar: TBD (MGMT *****) | | | |
| | | | | | |
| | | | | | |
| | 12 | Total | | 12 | Total |
| | | | | | |

Figure 4: An Example Study Plan

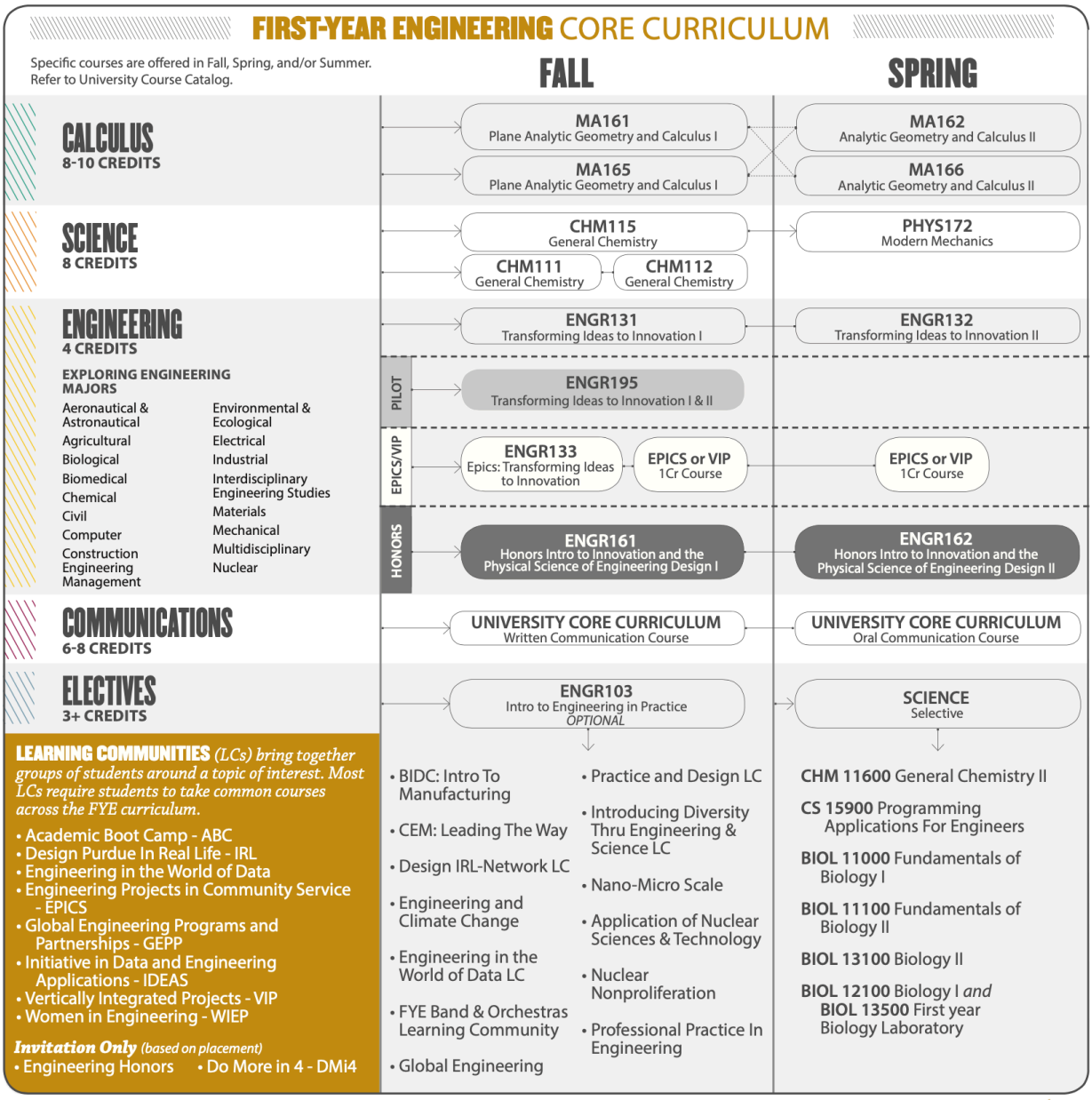



Figure 5: The First Year Engineering Curriculum

*The IBE program Engineering requirements include at least 6 credit hours of Engineering courses beyond the First-Year Engineering core curriculum that are required in a COE major. The list below shows Engineering courses with prerequisites included in IBE program. Note that some courses offered in two majors are similar, e.g. AAE203, ME274, CE298 are Dynamics courses. Only one of these courses will count towards IBE as indicated below. Courses indicated by * have very limited capacity for non-majors.*

**Engineering IBE Core Courses (6 Credits):**
*Pick at least 6 credits from the below courses –*

Computations for Eng Systems (ABE 20500)*
Thermodynanics (ME 20000)*
Basic Mechanics (CE 29700)* OR Basic Mechanics I (ME 27000)*
Life Cycle Eng & Mgmt of Constructed Facilities (CEM 20100)*
Electrical Engineering Fundamentals I (ECE 20001)
Environmental, Ecological & Eng Systems(EEE 25000)*
Environmental & Ecological Systems Modeling (EEE 30000)*
Probability & Statistics in Engineering (IE 23000)*
Engineering Economics (IE 34300)*
Structure and Properties of Materials (MSE 23000)*
Intro to Nuclear Engineering (NUCL 20000)*
Introduction to Engergy Engineering (NUCL 11000)
Nuclear Engineering Undergraduate Laboratory (NUCL 20500)* AND Introduction To Engineering In Practice: Nuclear Nonproliferation (ENGR 10300)

Figure 5: Engineering IBE Core Courses

**Preferred semesters for IBE Core Courses:**

| | |
|---|---|
| ABE 20500 Computations for Engineering Systems | Fall only |
| CE 29700 Basic Mechanics<br>(Equivalent to ME 27000) | Spring |
| CEM 20100 Life Cycle Engineering and Management of Constructed Facilities | Spring |
| ECE 20001 Electrical Engineering Fundamentals | Spring or Summer (On-Line Option Available in Summer) |
| EEE 25000 Environmental, Ecological and Engineering Systems | Fall only |
| EEE 30000 Environmental And Ecological Systems Modeling | Spring only |
| IE 23000 Probability and Statistics in Engineering I | Fall or Spring |
| IE 34300 Engineering Economics | Spring |

| | |
|---|---|
| ME 20000 Thermodynamics (Equivalent to ABE 20100) | Spring or Summer |
| ME 2700 Basic Mechanics I<br>(equivalent to CE 29700) | Spring or Summer<br>(On-Line Option Available Spring and Summer) |
| MSE 23000 Structure and Properties of Materials | Fall, Spring or Summer<br>(On-line Option Available in Summer) |
| Introduction to Engergy Engineering (NUCL 11000) | Fall Only |
| Introduction To Engineering In Practice: Nuclear Nonproliferation (ENGR 10300) | Fall |
| NUCL 20000 Introduction to Nuclear Engineering | Fall or Spring |
| NUCL 20500 Nuclear Engineering Undergraduate Laboratory | Spring only |

Figure 6: Preferred semesters for IBE Core Courses