

**EMR Robust EM Lessons and Assessments**

Author First Name	Author Last Name	Discipline(s)	EM@FSE Indicators Assessed	Module/Lesson/Assignment name	Description	Materials	To access links below: 1. Login to Canvas. 2. Click the Canvas Commons icon--just above Help on the Canvas navigation bar. 3. Return to this page and click any link. Link will open in Canvas Commons.
Gary	Lichtenstein	Any	All	Customer Discovery	This module contains resources for teaching Customer Discovery. It includes a PPT overview, link to a YouTube Customer Discovery demo, a 3-part interview with Dr. Brent Sebald on what customer discovery is and how to do it, 8 tips for conducting customer discovery interviews, and a quiz.	a PPT overview, a YouTube Customer Discovery demo, a 3-part interview with Dr. Brent Sebald, and a quiz.	<a href="https://or.instructure.com/resources/cd78da1f50ca43b7bfac601a60f08c">https://or.instructure.com/resources/cd78da1f50ca43b7bfac601a60f08c</a>
Gary	Lichtenstein	Any	All	EM@FSE Assessment Best Practices	This module includes materials for promoting EM Classroom Assessment Best Practices, which are lessons learned working with FSE faculty. The Quiz PPT introduces 6 Best Practices. The Samples PPT includes four actual examples of different assessments that reflect Best Practices. A 1-pg pdf summarizes and explains the Best Practices. The module includes a KEN Card template with Notes based on Gary's work with faculty.	a Quiz PPT, a Samples PPT, and a 1-pg pdf	<a href="https://or.instructure.com/resources/5c37895b95e04e1995f5a59e16a61177">https://or.instructure.com/resources/5c37895b95e04e1995f5a59e16a61177</a>
Michael	Clough	Any	a, c, d, m, q	Evidence-based Hypothesis Testing of Social & Global Biases	This project is designed for a sophomore/junior probability and statistics class that covers hypothesis testing. The project is intended to be delivered in three phases, with each phase being vetted and graded for accuracy and execution of the various techniques. This project is intended to be completed entirely out of class. Documents for students to review for completion of their project are attached.	2 word files: Project Grading Rubric, and Project description and Instructor Tips	<a href="https://or.instructure.com/resources/ca9395642c0a4c5b8a04dc6c68d229">https://or.instructure.com/resources/ca9395642c0a4c5b8a04dc6c68d229</a>
Jean	Andino	Chemical Engineering (CHE 442)	m, q	CHE 442- Infusing EM in an assignment about using Reactor Design to Help a Friend with Lactose Intolerance - by Jean Andino	Students are asked to (1) explore alternative pathways for generic enzymatic and enzyme-inhibited reactions and answer directed questions, (2) written design exercise to aid lactose intolerant chemistry student twins "Thimble" and "Thumble" decide on how much milk they can consume before their Lactaid pills (containing the enzyme needed to break down the milk sugars) no longer work and they become uncomfortable, (3) a technology solution to make predictions that help the chemistry twins to make informed decisions about their milk-drinking activities, and (5) a presentation (with an accompanying day for peer in-class viewing and voting) for the "unveiling" of the technology solution that will help the milk-loving chemistry student twins. This assignment explicitly assesses indicators m & q	10 files including 3 EM@FSE rubrics	<a href="https://or.instructure.com/resources/08379691fee145a48a04fc8172b14767shared">https://or.instructure.com/resources/08379691fee145a48a04fc8172b14767shared</a>
Jean	Andino	Chemical Engineering (CHE 442)	b, q	CHE442 - Infusing EM in an assignment about designing a homemade mask for minimizing airborne particle transmission-by Jean Andino	Students will design a single layer mask that balances the needs for a mask to filter effectively but yet remain "breathable". When designing, students should consider the following questions: What are the advantages of using a higher versus a lower thread count material in making a mask? Are there tradeoffs to consider? If so, what are those? How might the thread count impact the breathability (the pressure drop)? What other properties are important for your design? This assignment assesses EM@FSE indicators b & q.	6 files including one EM@FSE rubric	<a href="https://or.instructure.com/resources/efca879ae4e64236ac411a963668afa8">https://or.instructure.com/resources/efca879ae4e64236ac411a963668afa8</a>
Jean	Andino	Chemical Engineering (CHE 442)	a, q	CHE 442-Enhancing student curiosity through exploring chemical reactors - by Jean Andino	The assignment deliverables (a written document and presentation) require students to explore the use of chemical reactors in one of four different industries: food generation, paper products production, pollutant control (e.g. wastewater treatment), or pharmaceutical/therapeutics production. Teams will need to engage in "customer discovery" (i.e. research) using reputable sources such as peer-reviewed journal papers, government web sites, direct company information, or reputable documentaries. From the background research they will need to be able to describe the process that is used to create their final product, explicitly identify at least one of the chemical reactions that take place in the creation of the final product, identify the type(s) of reactor(s) that is/are used in the process, and identify the demand for the product in a quantitative way. This assignment assesses EM@FSE indicators a & q.	16 files including 2 EM@FSE rubrics	<a href="https://or.instructure.com/resources/1e3fb2e3acc74dc1bd76a51e00ec24e27shared">https://or.instructure.com/resources/1e3fb2e3acc74dc1bd76a51e00ec24e27shared</a>
Jean	Andino	Chemical Engineering, Environmental Engineering	b, c, q	Evaluating Pathways in Chemical Reactor Design	This lesson contains a module that deals with multiple reactions, including identifying reaction types and enhancing selectivity and yield. The module includes: (a) lecture notes to introduce the ideas behind multiple reactions, (b) suggested assignments and Excel/VBA-based tools, and (c) assessment rubrics.	1 Assessment Excel file, 5 word files for different activities, and 1 lecture pdf	<a href="https://or.instructure.com/resources/cbc236b348546408281767c4aef3746">https://or.instructure.com/resources/cbc236b348546408281767c4aef3746</a>
Mourir	El Asmar	Civil Engineering, Architectural Engineering, Engineering Management, Environmental Engineering, General Engineering, Mechanical Engineering	f, g, n, k, o	Designing a simple structure for a residential PV solar installation, including a business case	This team design project is the final activity as part of the Strength of Materials course (also referred to as deformable solids) to sophomore students in ASU's Del E. Webb School of Construction. Teams of students will work together in groups and participate in the development of a business case for mass-producing and installing a light residential structure that supports photovoltaic (PV) panels to help create a more sustainable environment.	A Project Rubric Excel file, and a word file of Instructor Tips	<a href="https://or.instructure.com/resources/b448c74749f40709c8e5371376c3ae">https://or.instructure.com/resources/b448c74749f40709c8e5371376c3ae</a>
Janaka	Balasoorya	Computer Science (CSE 240)	a, e, g, i, k, m	CSE240 - Infusing EM into an assignment about Sun Devil Software - by Janaka Balasoorya	Suppose a student is the chief technology officer (CTO) of the startup software company, Sun Devil Software. Main business of the Sun Devil software is developing embedded software systems for household appliances. Software developed by the company will be placed in microcontrollers in household items such as refrigerators, microwaves, washer-dryer units ... etc. The student's responsibility is to recommend a suitable programming language paradigm and a set of programming language choices for the company to use in developing software systems. First, they need to recognize potential customers for their company and their needs. Then, they need to determine suitable technology choices. This assignment assesses EM@FSE a, e, g, i, k, and m.	1 doc file CSE240_REML_Assessment, and 1 ppt file: CSE240_REML_Assessment_Submission_Template	<a href="https://or.instructure.com/resources/c58d4037d00c48c29a45e5db5e834dc">https://or.instructure.com/resources/c58d4037d00c48c29a45e5db5e834dc</a>
Ming	Zhao	Computer Science	f, i, k	Value Proposition- by Ming Zhao	In this assignment, students will interview their customers and develop the value proposition of their projects.	Customer Discovery assignment and Value Proposition word file.	<a href="https://or.instructure.com/resources/26c45af7bad24737338216f528851873shared">https://or.instructure.com/resources/26c45af7bad24737338216f528851873shared</a>
Ming	Zhao	Computer Science (CSE 485)	c	Issue Essay by Ming Zhao	The issue essay provides the students an opportunity to demonstrate their knowledge of local, national, and global contemporary issues that are relevant to your project.	Issue Essay assignment	<a href="https://or.instructure.com/resources/acb01880129f4212a62d70ab6868ca3773shared">https://or.instructure.com/resources/acb01880129f4212a62d70ab6868ca3773shared</a>
Anthony	Kuhn	Electrical & Computer Engineering	b, f, g, o	Applying Basic Circuit Analysis and Design to Vintage Radio Design	Students were asked to interview potential customers for a vintage radio using a tuning dial and volume dial. Using insights gained from those interviews, students designed a basic band-pass filter by sourcing real components and accounting for their tolerances. This lesson describes a mini-project designed to incorporate EM in an undergraduate junior level probability and random signal analysis course in Electrical Engineering. The goal of this mini-project is to let students practice analyzing real-world data set and apply probability concepts to gain insight from data. It also let students practice EM through using data to support and refute ideas and exploring multiple solution paths. This is a resistive network lab for a sophomore level Electrical Circuit Theory Course. The multi-disciplinary student teams are "hired" by Sparky Music. The over-riding project is to create an audio amplifier and filter that will "decode" their sample music. This specific lab asks them to first repair a broken CD player in order to sample the CD version of the music. The lab focuses on resistive networks, series and parallel connections, and real components versus ideal ones.	2 files: Radio Project EEE202, and Radio Project Rubric	<a href="https://or.instructure.com/resources/9b8c56642274685b1259277e9a89461">https://or.instructure.com/resources/9b8c56642274685b1259277e9a89461</a>
Chao	Wang	Electrical & Computer Engineering, Mechanical Engineering, Biomedical Engineering, Computer Science, General Engineering	b, c, o	Teaching Probability Using A Real World Data Set	This lesson describes a mini-project designed to incorporate EM in an undergraduate junior level probability and random signal analysis course in Electrical Engineering. The goal of this mini-project is to let students practice analyzing real-world data set and apply probability concepts to gain insight from data. It also let students practice EM through using data to support and refute ideas and exploring multiple solution paths. This is a resistive network lab for a sophomore level Electrical Circuit Theory Course. The multi-disciplinary student teams are "hired" by Sparky Music. The over-riding project is to create an audio amplifier and filter that will "decode" their sample music. This specific lab asks them to first repair a broken CD player in order to sample the CD version of the music. The lab focuses on resistive networks, series and parallel connections, and real components versus ideal ones.	3 files: mini_project_keen_assessment, mini_project_keen, and cal_housing data	<a href="https://or.instructure.com/resources/113fc16599b6404595b75f609c5728b">https://or.instructure.com/resources/113fc16599b6404595b75f609c5728b</a>
Marnie	Wong	Electrical & Computer Engineering, Biomedical Engineering, Computer Science, General Engineering	b, g, i, o, p, q	Sparky Music - Using Entrepreneurial Mindset to "Spark" the Understanding of Resistive Networks in a Circuits Lab	This assignment assesses the understanding and application of series and parallel network connections and power in a sophomore level introductory circuits class. Students are asked by a Sparky Solar contractor to design a solar panel and battery module configuration for a single-family dwelling. This assignment takes concepts and theories that have been practiced in class (series and parallel resistor connections, power and energy calculations, circuit supplies and passive devices) and combines them with the EM skills of applying technical knowledge to the development of a product (EM@FSEg) and modifying a product based on feedback (EM@FSEh).	2 files: Lab 2 Rubric and CLOs, and EEE 202 Lab 2 Resistor Networks	<a href="https://or.instructure.com/resources/8113c1393c36d42fa5eed795e160fb6">https://or.instructure.com/resources/8113c1393c36d42fa5eed795e160fb6</a>
Marnie	Wong	Electrical & Computer Engineering, Biomedical Engineering, Mechanical Engineering, Computer Science, General Engineering	g, h	EEE 202 - Infusing EM into an assignment about designing Series/Parallel Resistor Networks for Solar Power Applications - by Marnie Wong	This assignment assesses the understanding and application of nodal and loop analysis in a sophomore level introductory circuits class. Students use nodal analysis or loop analysis to determine which kit Sam (a kid they know) should buy to meet the voltage requirement of the headlights via for a radio controlled (RC) car. This assignment takes concepts and theories that have been practiced in class (resistive circuit simplification and nodal and loop analysis) and combines them with the EM skills of gathering data to support and refute ideas (EM@FSEc) and applying technical knowledge to the development of a product (EM@FSEg).	1 pdf file: 01_Series-Parallel-Power	<a href="https://or.instructure.com/resources/1b7aac62f01846368dc1e8e4d94bad5">https://or.instructure.com/resources/1b7aac62f01846368dc1e8e4d94bad5</a>
Marnie	Wong	Electrical & Computer Engineering, Biomedical Engineering, Mechanical Engineering, Computer Science, General Engineering	c, g	EEE 202 - Infusing EM into an assignment using Nodal and Loop Analysis - by Marnie Wong	This assignment assesses students' understanding and application of Op-Amp Circuits in a sophomore level introductory circuits class. Student teams are hired by Sparky Medical to design an op-amp configuration for a wearable eye sensor circuit. Presented in this customer-framed scenario, the students may better see how the application of op-amps may apply to their field and how the circuit analysis methods they've learned connect to actual design decisions. This assignment also helps to demonstrate multiple ways to solve a problem and how to design with given constraints. This assignment takes concepts and theories that have been practiced in class (ideal op-amp circuit implementation) and combines them with the EM skills of exploring multiple solution paths (EM@FSE b), applying technical knowledge to the development of a product (EM@FSE g), and engaging in actions with the understanding that they have potential to lead to both gains or losses (EM@FSEe).	1 pdf file includes the assignment content and rubric	<a href="https://or.instructure.com/resources/61a031fc1866448e8b26323ed036e084">https://or.instructure.com/resources/61a031fc1866448e8b26323ed036e084</a>
Marnie	Wong	Electrical & Computer Engineering, Biomedical Engineering, Mechanical Engineering, Computer Science, General Engineering	b, g, l	EEE 202 - Infusing EM into Designing the Feedback Network of an Op-Amp Circuit - by Marnie Wong	This assignment assesses the understanding and application of First Order Transient Circuits in a sophomore level introductory circuits class. Student teams are hired by a new gameshow called, "Spark Session" to design a timer circuit for their "Beat the Clock Challenge". Presented in this customer-framed scenario, the students may better see how the application of first order transient circuit analysis may apply to their field and how the circuit analysis methods they've learned connect to actual design decisions. This assignment takes concepts and theories that have been practiced in class (first order transient circuit analysis) and combines them with the EM skill of applying technical skills/knowledge to the development of a technology/product (EM@FSEg).	1 pdf file: Op-Amps	<a href="https://or.instructure.com/resources/35b3213677be4a069c4099a4a4473b373shared">https://or.instructure.com/resources/35b3213677be4a069c4099a4a4473b373shared</a>
Marnie	Wong	Electrical & Computer Engineering, Biomedical Engineering, Mechanical Engineering, Computer Science, General Engineering	g	EEE 202 - Infusing EM into an assignment on Designing a Game Show Buzzer using First Order Transient Analysis Methods - by Marnie Wong	This assignment assesses the understanding and application of a technology/product (EM@FSEg).	1 pdf file: 05 LC First Order Circuits	<a href="https://or.instructure.com/resources/37b7e3d9382f4a9baef5b0b618e19617shared">https://or.instructure.com/resources/37b7e3d9382f4a9baef5b0b618e19617shared</a>

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Author First Name	Author Last Name	Discipline(s)	EM@FSE Indicators Assessed	Module/Lesson/Assignment name	Description	Materials	To access links below: 1. Login to Canvas. 2. Click the Canvas Commons icon--just above Help on the Canvas navigation bar. 3. Return to this page and click any link. Link will open in Canvas Commons.
Marnie	Wong	Electrical & Computer Engineering, Mechanical Engineering, Biomedical Engineering, Computer Science, General Engineering	i, q	EEE 202 - Infusing EM into an assignment about Demonstrating Impulse Response using a Second Order Transient Circuit - by Marnie Wong	This assignment assesses the understanding and application of Second Order Transient Circuits in a sophomore level introductory circuits class. Student teams are tasked with creating a circuit to replicate the "damped harmonic oscillator" designed by Sparky Motors. Presented in this customer-framed scenario, the students see how the application of second order transient circuit analysis may apply to their field and how the circuit analysis methods they've learned connect to actual design decisions. This assignment takes concepts and theories that have been practiced in class (second order transient circuit analysis) and combines it with the EM skills of integrating/synthesizing different kinds of knowledge (EM@FSE q) and engaging in acts with the understanding that they have potential to lead to both gains or losses (EM@FSE l).	1 doc file includes the assignment overview, and 1 pdf file includes the assignment content and the rubric.	<a href="https://or.instructure.com/resources/86ba8cd50d34995949881faecc296b67shared">https://or.instructure.com/resources/86ba8cd50d34995949881faecc296b67shared</a>
Marnie	Wong	Electrical & Computer Engineering, Mechanical Engineering, Biomedical Engineering, Computer Science, General Engineering	m	EEE 202 - Infusing EM into an assignment using Phasors to Analyze an Induction Motor Circuit - by Marnie Wong	Students are asked by Sparky Industrials to optimize the circuitry for an induction motor used in a water pump. Presented in this customer-framed scenario, the students may better see how the application of phasors may apply to their field and how the circuit analysis methods they've learned connect to actual design decisions. This assignment takes concepts and theories that have been practiced in class (phasors and AC circuit analysis) and combines them with EM skill of articulating an idea to diverse audiences (EM@FSE m).	1 doc file:EEE 202 ASU Sync Assignment 7 - Overview and 1 pdf file: 07 Phasors	<a href="https://or.instructure.com/resources/4c90c9774a1648119a9470bec4512790">https://or.instructure.com/resources/4c90c9774a1648119a9470bec4512790</a>
Marnie	Wong	Electrical & Computer Engineering, Mechanical Engineering, Biomedical Engineering, Computer Science, General Engineering	g, o, m, q	EEE 202 - Infusing EM into creating a circuits concept map - by Marnie Wong	This assignment requires sophomore students to define each of the technical concepts in a basic circuits course as clearly and precisely as they can, and, using concept mapping, state the associated units and the unit abbreviations [e.g., volts (V)]. This assignment assesses EM@FSE indicators g, o, m, q.	1 pdf file includes the assignment content and the EM@FSE rubric.	<a href="https://or.instructure.com/resources/d40c5d9593294fe9a571ac4d9cc44553">https://or.instructure.com/resources/d40c5d9593294fe9a571ac4d9cc44553</a>
Marnie	Wong	Electrical & Computer Engineering, Mechanical Engineering, Biomedical Engineering, Computer Science, General Engineering	a, b, c, f, g, h, i	FSE 100 Final Report - A Summary of the Design Project with focus on Creating Value - by Marnie Wong	Students take on the role of an engineer in a humanitarian relief company called Sparky Aid Designs. The company is exploring a market for an aircraft that can be used in disaster relief scenarios. As a part of this project, students will be 1) identifying different design opportunities based on researching the problem, 2) learning different technical skills that will allow them to design solutions to key subsystems of the airplane, 3) modeling and testing their designs, and 4) communicating their design and process in a final report. This final report serves to assess a semester's worth of working through the design process to determine the implementation of EM objectives in their work. This assignment assesses EM@FSE indicators a, b, c, f, g, h, i.	2 doc files: Project Description to upload & Final Report RUBRIC, and 1 pdf file: Final Report	<a href="https://or.instructure.com/resources/9a51f020365c43ad9d776f7a14b9f9b9">https://or.instructure.com/resources/9a51f020365c43ad9d776f7a14b9f9b9</a>
Mackenzie	Boyer	Environmental Engineering (CEE 361)	c, o, q	CEE 361 - Infusing EM into a lab assignment exploring Biochemical Oxygen Demand - by Mackenzie Boyer	Students and a group of their root-beer-float, tubing-, and fishing-loving friends are designing a relaxation destination to be named "Root Beer Floats". Their job is to perform an initial environmental impact assessment of their proposed root beer facility, and use this information to: determine if the facility's effluents will negatively impact aquatic life. Based on their analyses, students must recommend effective better wastewater treatment (Lw or DOW), reduced flow (Qw), and/or move the wastewater discharge point to protect the trout population. Recommendations should include whether and how project components (i.e., manufacturing root beer, 2- tubing, and/or 3- fishing) should be implemented. This assignment assesses EM@FSE indicators c, o, and q.	1 doc file: CEE 361 Lab 3- Biochemical Oxygen Demand-EM@FSE	<a href="https://or.instructure.com/resources/dc8862d96f1441c1a24ef6b7d40a542d">https://or.instructure.com/resources/dc8862d96f1441c1a24ef6b7d40a542d</a>
Mackenzie	Boyer	Environmental Engineering (CEE 361)	c, o, e, p	CEE 361 Infusing EM into Air Quality and Redlining- by Mackenzie Boyer	The assignment is framed stating that the Eastlake Park neighborhood in Phoenix, Arizona (a real neighborhood) is fictionally considering a potential lawsuit against the City alleging (real life) discriminatory lending and development practices that have led to increased environmental risks in their community. Students have been (fictionally) hired by the City of Phoenix to investigate the validity of the Eastlake Park neighborhood's claim by performing an initial air quality assessment and recommending mitigation. This assignment will enable students to gain an understanding of air quality engineering through data analysis, compare air quality and temperature trends among several sampled locations in order to develop a spatial understanding of the impact of the built environment on air quality. The lab contextualize air quality within urban planning practices of redlining and redevelopment. It assess EM@FSE c, e, o, and p.	1 doc file: CEE 361 Lab 4- Air Quality and Redlining- EM@FSE	<a href="https://or.instructure.com/resources/9a51f020365c43ad9d776f7a14b9f9b9">https://or.instructure.com/resources/9a51f020365c43ad9d776f7a14b9f9b9</a>
Mackenzie	Boyer	Environmental Engineering (CEE 361)	c, o, p, q	CEE 361-Infusing EM in an assignment about water quality measurement-by Mackenzie Boyer	Students play the role of an environmental engineer interning for the Arizona Department of Environmental Quality (ADEQ) and work in the Water Quality Division. Their job is to collect water samples and take them back to the laboratory for analysis. On their first day on the job, they collect water samples from the six locations. Unfortunately, some prankster replaced their marker that they used to label your samples with a disappearing ink marker. Students can't go back to collect more samples, but they still want to successfully complete the first task that your boss has given them. They can analyze the water samples in the laboratory for pH, conductivity, turbidity, alkalinity, hardness, and chlorine. Therefore, they research what the water quality values are for each of the six waters, and they will be able to use their engineering judgement to determine the proper identity of each water sample.	1 doc file: CEE 361 Lab 1- Water Quality- EM@FSE	<a href="https://or.instructure.com/resources/3c0068d9ee04e3f39c6c701dc458f899">https://or.instructure.com/resources/3c0068d9ee04e3f39c6c701dc458f899</a>
Jay	Patel	Mechanical & Aerospace engineering (AEE 325)	a, c, g, q	AEE 325 - Infusing EM into a Stress Analysis Lab Assignment - by Jay Patel	This assignment is designed for faculty teaching junior level engineering students in mechanical and aerospace engineering. One of the labs involves students conducting stress analysis on flat plates with varying sized holes subjected to tensile load. Students are to provide recommendations to Southwest Airlines lead maintenance engineer to determine the structural integrity for intended application in the fuselage construction. Students will use the concepts of fracture mechanics and failure prevention to draw conclusions upon which to base recommendations. This assignment assesses EM@FSE indicators a, c, g, and q.	1 pdf file: AEE325_EM_Assignment_deliverables rubric	<a href="https://or.instructure.com/resources/9a51f020365c43ad9d776f7a14b9f9b9">https://or.instructure.com/resources/9a51f020365c43ad9d776f7a14b9f9b9</a>
Darryl	Morrell	Mechanical Engineering, Manufacturing Engineering, General Engineering	c,g,i,m	EGR 401-Infusing EM in the Final Presentation -by Darryl Morrell	The Capstone students present their team's progress of the semester-- the first half of their comprehensive project-- to their peers, faculty, and their industry partner. They should present their project problem statement; a brief summary of their chosen design concept; the detailed mechanical, electrical, and software designs at high level; the preliminary bill of materials; the engineering analysis; the high-level test plan developed with this analysis; an updated assessment of their risks and identify those that have been triggered; and describe how they plan to mitigate risks (this project will be continued in EGR 402). This assignment assesses EM@FSE c, g, i, and m.	2 files: a doc file describes the assignment, and an Excel rubric	<a href="https://or.instructure.com/resources/79c04f66ec8d478da2403e9d572755b6">https://or.instructure.com/resources/79c04f66ec8d478da2403e9d572755b6</a>
Darryl	Morrell	Mechanical Engineering, Manufacturing Engineering, General Engineering	b,c,f,n	EGR 401-Infusing EM in the Final Report Assignment-by Darryl Morrell	This is a professional document that details all of the work a student team has performed in EGR 401. Each student is required to identify individual contributions to the report. Students have to explain the value of their innovation to each stakeholder (EM@FSE n); tie the requirements to customer needs through the Voice of the Customer (EM@FSE f); describe the concept generation process and summarize the generated concepts (EM@FSE b); describe the concept selection process and justify the final selected concept using a formal concept selection method, and evaluate existing solutions relative to requirements (EM@FSE c). This assignment assesses EM@FSE b, c, f, and n.	2 files: a doc file describes the assignment, and an Excel rubric	<a href="https://or.instructure.com/resources/79c04f66ec8d478da2403e9d572755b6">https://or.instructure.com/resources/79c04f66ec8d478da2403e9d572755b6</a>
Darryl	Morrell	Mechanical Engineering, Manufacturing Engineering, General Engineering	c, g, h, m	EGR 402-Infusing EM in the Final Presentation -by Darryl Morrell	This is the final presentation of the second half of the comprehensive project, and students are to communicate their major outcomes of their project to their peers, faculty mentor, and your industry partner. The presentation should include the engineering analysis done on their design/prototype (EM@FSE g); use their test results to determine whether their project met their success criteria (EM@FSE c); describe the modifications made to the design on the basis of the test results (EM@FSE h); articulate the presentation to the audiences logically(EM@FSE m).	2 files: a doc file describes the assignment, and an Excel rubric	<a href="https://or.instructure.com/resources/60d7f88f398e4f6a8028f3f2dc0cc39">https://or.instructure.com/resources/60d7f88f398e4f6a8028f3f2dc0cc39</a>
Darryl	Morrell	Mechanical Engineering, Manufacturing Engineering, General Engineering	c,g,h,i,l	EGR 402-Infusing EM in the Final Report -by Darryl Morrell	This team assignment is to document students' work and project outcomes including design, simulation, modeling, analysis, construction, testing and validation, and other activities. Each student is required to identify individual contributions to the report. Students will describe the problem being solved, its value, and its importance to the project stakeholders (EM@FSE i). Students describe their design, the prototype, the process used to construct it, and the engineering analysis (EM@FSE g). They will use test results to determine whether their project met their success criteria (EM@FSE c). They will describe the modifications made to the design based on the test results (EM@FSE h); and identify potential gains and losses that stakeholders might experience because of the project. This assignment assesses EM@FSE c, g, h, i, and l.	3 files: a doc file describes the assignment, and an Excel rubric	<a href="https://or.instructure.com/resources/9a51f020365c43ad9d776f7a14b9f9b9">https://or.instructure.com/resources/9a51f020365c43ad9d776f7a14b9f9b9</a>
Darryl	Morrell	Mechanical Engineering, Manufacturing Engineering, General Engineering	c, k	EGR 401-Infusing EM in an assignment about the Competitive Benchmarking Paper -by Darryl Morrell	Students are required to rigorously perform the competitive benchmarking activities. They evaluate each of the existing solutions relative to all requirements and success criteria (EM@FSE c). They also need to provide a reasonable explanation about how each existing solution affects the market (EM@FSE k). This assignment assesses EM@FSE c and k.	2 files: a doc file describes the assignment, and an Excel rubric	<a href="https://or.instructure.com/resources/3086d0286c03415685b5d9e8e89b07c">https://or.instructure.com/resources/3086d0286c03415685b5d9e8e89b07c</a>
Darryl	Morrell	Mechanical Engineering, Manufacturing Engineering, General Engineering	e,l	Infusing EM in an assignment about the Ethics and Professionalism Paper -by Darryl Morrell	Students are required to create a reflective document about their understanding of ethical and professional responsibilities. They need to describe the potential gains and losses that could result from the project (EM@FSE l). They identify who would benefit from the gains and suffer because of losses. They describe how the potential losses have been or will be communicated with project stakeholders. They describe individual long-term professional goals and ties them to projected trends (EM@FSE e). This assignment assesses EM@FSE e and l.	3 files: a doc file describes the assignment, and an Excel rubric	<a href="https://or.instructure.com/resources/6dc120104db7c4b0b868d9f2c345e46">https://or.instructure.com/resources/6dc120104db7c4b0b868d9f2c345e46</a>
Darryl	Morrell	Mechanical Engineering, Manufacturing Engineering, General Engineering	n, o, q	Infusing EM in an assignment about the Informed Decisions and Strategic Learning Paper -by Darryl Morrell	Students are required to create a reflective document identifying different kinds of knowledge that were learned (EM@FSE q). They describe how the interdependence of technology, the environment, society, the economy, and other areas has affected the project using concrete examples from the project work. They also identify realistic consequences that this interdependence may create (EM@FSE o). They provide a compelling explanation of how the project provides value to each of the identified stakeholders (EM@FSE n). This assignment assesses EM@FSE n, o, and q.	2 files: a doc file describes the assignment, and an Excel rubric	<a href="https://or.instructure.com/resources/0ff1d4983b84424c9d81f8587e7a95bf">https://or.instructure.com/resources/0ff1d4983b84424c9d81f8587e7a95bf</a>

EMR Robust EM Lessons and Assessments							
Author First Name	Author Last Name	Discipline(s)	EM@FSE Indicators Assessed	Module/Lesson/Assignment name	Description	Materials	To access links below: 1. Login to Canvas. 2. Click the Canvas Commons icon—just above Help on the Canvas navigation bar. 3. Return to this page and click any link. Link will open in Canvas Commons.
Darryl	Morrell	Mechanical Engineering, Manufacturing Engineering, General Engineering	f, i, o	Infusing EM in an assignment about the Voice of the Customer Paper - by Darryl Morrell	Students are required to describe the ecosystem in which the industrial partner and their customers exist. They describe the relationships between elements of this ecosystem (EM@FSE o). They document at least one interview, five customer needs and/or wants, and these are expressed in the customers' own words (EM@FSE f). They document how solving the problem will provide value for the customers Lastly, they describe how this value will affect the market in which the industrial partner competes (EM@FSE i). This assignment assesses EM@FSE f, i, and o.	2 files: a doc file describes the assignment, and an Excel rubric	<a href="https://or.instructure.com/resources/449a348ce274754d5f8fcb9a412eb89f9e">https://or.instructure.com/resources/449a348ce274754d5f8fcb9a412eb89f9e</a>
Gennaro	De Luca	Information Technology	a, e, g	Infusing EM in a milestone 1 assignment of an IFT capstone course about investing in new innovative technology-by Gennaro De Luca	Students play the role of the Executive Vice-President of Product and Innovation Strategy. They are asked to present to the Steering Committee on what it will take to invest in new, innovative technology. They will describe the crowd-funding research that they have considered to be an innovative technology or innovative use of existing technology. They will provide a scenario about how the new technology would be used. They will also explain what would need to change for each of the 5 components (hardware, software, data, procedures, and people) to implement the innovative technology. This assignment assesses EM@FSE a, e, and g.	A doc file includes both the assignment	<a href="https://or.instructure.com/resources/332b4bebb4b34168fcb80d1690f86f29">https://or.instructure.com/resources/332b4bebb4b34168fcb80d1690f86f29</a>
Gennaro	De Luca	Information Technology	a, m, p	Infusing EM in a milestone 2 assignment of an IFT capstone course about conceptualization and technology solution-by Gennaro De Luca	Students are required to describe the business that will be using their product/technology solution. They also describe the problem/opportunity, and discuss the impact of the problem on surroundings and value in solving the problem. Additionally, they describe the technology solution, how it addresses the problem, and the required technical skills. This assignment will take 2-4 weeks to finish, and it assesses EM@FSE a, m, and p.	A doc file includes both the assignment	<a href="https://or.instructure.com/resources/454264529b94fa86f081896ac3750d0">https://or.instructure.com/resources/454264529b94fa86f081896ac3750d0</a>
Gennaro	De Luca	Information Technology	a, b, c, e, g, i, m, p	Infusing EM in a milestone 3 assignment of an IFT capstone course about Project Charter-by Gennaro De Luca	Students are required to describe the business that will be using their product/technology solution. Their solution will have a user interface, application, database components, and security. They also describe the quantifiable benefits of their solution. They identify stakeholders, and explain why the solution adds value to different stakeholders. In addition, they explain the technology tools and System Development Life Cycle that they will use to develop and implement their solution. This assignment will take 2-4 weeks to finish, and it assesses EM@FSE a, b, c, e, g, i, m, and p.	A doc file includes both the assignment	<a href="https://or.instructure.com/resources/792ced78bf0c4ea9a756ee0d1746c1c2">https://or.instructure.com/resources/792ced78bf0c4ea9a756ee0d1746c1c2</a>
Gennaro	De Luca	Information Technology	a, g, h, i, p	Infusing EM in a milestone 4 assignment of an IFT capstone course about conducting fact-finding techniques to help create the System Requirements-by Gennaro De Luca	Students play the role of a System Analyst who will conduct fact-finding techniques to help create the System Requirements. They are required to discuss the impact of the problem on surroundings and value in solving the problem. They describe the technology solution, how it addresses the problem, and the required technical skills. They also create a Use Cases and Map the major functions and requirements for each function. This assignment will take at least 4 weeks to finish, and it assesses EM@FSE a, g, h, i, and p.	A doc file includes both the assignment	<a href="https://or.instructure.com/resources/f8492d9050fe476c8118cc06a4d7865">https://or.instructure.com/resources/f8492d9050fe476c8118cc06a4d7865</a>
Gennaro	De Luca	Information Technology	a, g, h, i, p, q	Infusing EM in a milestone 5 assignment of an IFT capstone course about programming and creating webpages-by Gennaro De Luca	Students are required to discuss the impact of the problem on surroundings and value in solving the problem. They create the wireframes (illustration of your screens/webpages), and describe the purpose of the page. They also create a network topology that includes all relevant devices and the required infrastructure. They create an entity-relationship diagram that includes all required data. Additionally, they discuss 3 security risks, how they will handle confidentiality, integrity, and availability. They list the development tools and programming languages that they will use and explain why. This assignment will take at least 4 weeks to finish, and it assesses EM@FSE a, g, h, i, p, and q.	A doc file includes both the assignment	<a href="https://or.instructure.com/resources/6e4832928294f112aabcdd44d4a69dc">https://or.instructure.com/resources/6e4832928294f112aabcdd44d4a69dc</a>
Anoop	Grewal	General Engineering, Mechanical and Aerospace Engineering, Electrical Engineering	a, g, i	Infusing EM in designing a circuit and code for automated nursery shade structures-by Anoop Grewal	A local nursery is looking to make automatic and individual shading structures for their small 1-gallon plants, to protect these young plants from the harsh sun. The shade structure will come up whenever the light goes beyond a particular threshold. Students will design the circuit and write the code, so that when the light intensity increases the servo motor will actuate to cover the plant with a small canopy. Implicitly, they will use the principles of resistors in series, and connecting elements in parallel. After the activity, the students will discuss issues related to the physical implementation, pitching their design to the customer, and address any feedback. This assignment assesses EM@FSE a, g, and i.	3 files: 1 doc file about the lesson plan	<a href="https://or.instructure.com/resources/fb72466586894baea1e09cab55bab3a3">https://or.instructure.com/resources/fb72466586894baea1e09cab55bab3a3</a>
Anoop	Grewal	General Engineering, Mechanical and Aerospace Engineering, Electrical Engineering	f	Infusing EM in an FSE 100 assignment about making a minimally viable stairlift on a small scale-by Anoop Grewal	Students are required to make a minimally viable stairlift on a small scale, which is a factor of 12 smaller in size, and a factor of 300 smaller in mass. This stairlift is designed for a grandmother to move between the first and second floors. This is the first lab, and students will only make the mechanical design that uses a motor to move. They will analyze the provided customer statement and make a list of at least 6 design requirements for executing the project (EM@FSE f).	3 pdf files including one rubric.	<a href="https://or.instructure.com/resources/6e283b77f044cc0b8e4cd93c7182d2c">https://or.instructure.com/resources/6e283b77f044cc0b8e4cd93c7182d2c</a>
Spring	Berman	General Engineering, Mechanical and Aerospace Engineering, Electrical Engineering	b, c, g, m	Infusing EM in a project about Aircraft Pitch Control-by Anoop Grewal	Students have been asked to advise Sparky Airline executives on a solution to the following problem: The airline is introducing a new daily non-stop flight from Phoenix to Boston. The executives would like to minimize the consumption of fuel during the flight in order to reduce greenhouse gas emissions. Students need to use their technical knowledge of aircraft dynamics and controls, along with the given technical specifications, to devise a way to fly the plane from 10,600m to 11,000m as quickly as possible while ensuring that the passengers are comfortable. This assignment assesses EM@FSE b, c, g, and m.	9 files including 3 guidelines/rubrics for 3 parts	<a href="https://or.instructure.com/resources/a1b72afe547b4707b1880c3eb66d7f6">https://or.instructure.com/resources/a1b72afe547b4707b1880c3eb66d7f6</a>
Anoop	Grewal	General Engineering, Mechanical and Aerospace Engineering, Electrical Engineering	c, g, m	Infusing EM in making a hoverboard-by Anoop Grewal	Students are required to design a hoverboard with given requirements. They can use their mathematical modeling skills to check if the design is feasible while creating a physical prototype (after all that's the point of mathematical modeling). They will write a short report to present their design in detail to rigorously prove or disprove the possibility of hoverboards. For example, if their design relies on batteries, motors, and propellers, then they must have a rough schematic with sizes of various components. They must then show all the calculations they performed and the data they gathered to prove that the requirements above are met or not possible to be met. This assignment assesses EM@FSE a, g, and m.	2 files: one rubric and one description of the assignment	<a href="https://or.instructure.com/resources/fb72466586894baea1e09cab55bab3a3">https://or.instructure.com/resources/fb72466586894baea1e09cab55bab3a3</a>
Michael	Goryll	Any	a, e, m	Infusing EM in an ASU 101 semester summary assignment-by Michael Goryll	Students are required to make a 2-minute Power Point SWOT analysis (Strengths/weaknesses/opportunities/threats analysis) in which they reflect on the Highlights and Lowlights of the past semester with respect to the original semester goals (EM@FSE e), articulate goals to be accomplished during the next semester (EM@FSE a), and design a visually appealing presentation and deliver it to an audience. (EM@FSE m).	3 files: 1 PPT teaching EM, 1 doc including description and rubric for the assignment, and 1 PPT example	<a href="https://or.instructure.com/resources/012483ab77f044cc5a6e0812c14a7d97f">https://or.instructure.com/resources/012483ab77f044cc5a6e0812c14a7d97f</a>
Michael	Goryll	Electrical & Computer Engineering, Computer Science, General Engineering	b, f, g, h, i, l, n, m	Infusing EM in a 200 level course assignment about Capstone Design Project-by Michael Goryll	A leading provider for Video Conferencing Systems is running into a problem with their newest technology. If two participants connect via their laptops and want to use their computer audio, annoying audio feedback can develop. The company asks students to design more intelligent audio feedback suppression controller. They already developed a feedback detector. The students need to design two finite state synchronous machines and add functionality to the design as they see fit, and they can demonstrate them to their stakeholders. The students need to address why the project is needed (EM@FSE m), state a clear and concise mapping between design choices and proposed values (EM@FSE l), make changes based on stakeholder feedback (EM@FSE h), etc.	2 doc files: one description and one rubric for the assignment	<a href="https://or.instructure.com/resources/be6018fae5f347e7ab0c1946bd5181ee">https://or.instructure.com/resources/be6018fae5f347e7ab0c1946bd5181ee</a>
Ryan	Meuth	Computer Science (CSE 423)	m, n	Infusing EM in an ethics and individual project report-by Ryan Meuth	Students are required to summarize their contributions to the project over the semester, and a reflection on their performance and how they can improve. They also need to describe the value personally created for their customer, in economic, social and/or environmental context. This report assesses EM@FSE m and n.	3 files: a PPT lesson, a doc file describing the ethics & individual project report, and an individual project reflection.	<a href="https://or.instructure.com/resources/7998dc5a288d415e4822898d119b9a50">https://or.instructure.com/resources/7998dc5a288d415e4822898d119b9a50</a>
Ryan	Meuth	Computer Science (CSE 424)	f, g, h, p	Infusing EM in a Sprint Retrospective Assignment-by Ryan Meuth	Each student must complete at least one sprint summary about their Sprint activities during the semester. Students describe the product's features and summarize the owner feedback they have collected (EM@FSE f). Students present their response to their customer feedback (EM@FSE h). This assignment assesses EM@FSE f, g, h, and p.	3 files: a Scrum quiz, Sprint Retrospective assignment, and the description of project development assignment.	<a href="https://or.instructure.com/resources/7834a38e97c74931b60249d1bd813823">https://or.instructure.com/resources/7834a38e97c74931b60249d1bd813823</a>
Shahriar	Anwar	General Engineering	b, g, h, j, and p	Infusing EM in a "Walk on Water" design project-by Shahriar Anwar	Students will work in teams to design, fabricate, and utilize a contraption that they will use to "walk" across the ASU Recreation Center swimming pool. They must work within budgetary and other constraints. Students have to brainstorm three possible designs with accurate and complete figures, and discuss pros and cons of each design (EM@FSE b). They address buoyancy, stability, steering, durability, speed, and manufacturability issues (EM@FSE g). They incorporate all the feedback from the instructors on the intermediate assignments (EM@FSE h). This assignment assesses EM@FSE b, g, h, j, and p.	one doc file including both the assignment description and a rubric	<a href="https://or.instructure.com/resources/8e7d599d31f24c83bf9ae40fa44e4a3">https://or.instructure.com/resources/8e7d599d31f24c83bf9ae40fa44e4a3</a>
Shahriar	Anwar	General Engineering	b, g, h, m and p	Infusing EM in designing and building a geodesic dome-by Shahriar Anwar	Teams will design and build a geodesic dome out of the material(s) of their own choosing, subject to constraints. The winning team will participate in the national competition held by ASM International for a chance to win a grand prize of \$1,000. Students have to brainstorm three possible designs with accurate and complete figures, and discuss pros and cons of each design (EM@FSE b). They must address all three of the technical issues, namely, load carrying ability from specific load points, strength-to-weight ratio, and strength-to-cost ratio (EM@FSE g). They incorporate all the feedback from the instructors on the intermediate assignments (EM@FSE h). This assignment assesses EM@FSE b, g, h, m and p.	one doc file including both the assignment description and a rubric	<a href="https://or.instructure.com/resources/6c4e35dd6cc049e4ac126fe5af35c31d">https://or.instructure.com/resources/6c4e35dd6cc049e4ac126fe5af35c31d</a>

<b>EM@FSE Indicators</b>							
<b>a</b>	Critically observes surroundings to recognize opportunity						
<b>b</b>	Explores multiple solution paths						
<b>c</b>	Gathers data to support and refute ideas						
<b>d</b>	Suspends initial judgement on new ideas						
<b>e</b>	Observes trends about the changing world with a future-focused orientation/perspective						
<b>f</b>	Collects feedback and data from many customers and customer segments						
<b>g</b>	Applies technical skills/knowledge to the development of a technology/product						
<b>h</b>	Modifies an idea/product based on feedback						
<b>i</b>	Focuses on understanding the value proposition of a discovery						
<b>j</b>	Describes how a discovery could be scaled and/or sustained, using elements such as revenue streams, key partners, costs, and key resources						
<b>k</b>	Defines a market and market opportunities						
<b>l</b>	Engages in actions with the understanding that they have the potential to lead to both gains or losses						
<b>m</b>	Articulates the idea to diverse audiences						
<b>n</b>	Persuades why a discovery adds value from multiple perspectives (technological, societal, financial, environmental, etc.)						
<b>o</b>	Understands how elements of an ecosystem are connected						
<b>p</b>	Identifies and works with individuals with complementary skill sets, expertise, etc.						
<b>q</b>	Integrates/synthesizes different kinds of knowledge						

## EM@FSE(a-q) Indicator Coverage Explained EAC

*Entrepreneurial Mindset* (<https://engineeringunleashed.com/>) goes beyond the concept of traditional entrepreneurship and “start-up” mentality to equip engineers with the skills and mindset to **Exercise Curiosity, Make Connections, and Create Value** for industry, society, and the environment. Students reflect an entrepreneurial mindset when demonstrating competence on the EM@FSE Indicators a-q.

*An ABET skillset + EM Mindset=An FSE Engineer with ABET +EM*

ABET is the agency that accredits all engineering programs in the US and in other countries. ABET shapes the engineering curricula

EM@FSE 2.0 Indicator linked to ABET Student Outcomes	Explanation
<b>ABET+EM #1</b> <b><i>The FSE Engineer critically observes surroundings to recognize opportunities and apply engineering principles, technical skills, science, and mathematics to solve complex engineering problems.</i></b>	
a) Critically observes surroundings to recognize opportunity	Recognizing opportunity begins with being aware of what’s going on around you, noticing what is so common that we don’t even think about it as well as what’s strange within the ordinary. The FSE Engineer recognizes opportunities to apply engineered solutions to everything from day-to-day problems all the way up to grand challenges.
g) Applies technical skills/knowledge to the development of a technology/ product	This is ABET Student Outcome Criterion #1.
<b>ABET+EM #2</b> <b><i>The FSE Engineer can apply human-centered design principles to discover users’ needs, value propositions and market opportunities, to meet specified needs with consideration of public health, safety, and welfare, and global, cultural, social, environmental, and economic factors. Explores multiple solution paths, suspending judgement on new ideas.</i></b>	
b) Explores multiple solution paths	The FSE Engineer frames and reframes social and engineering problems in order to generate multiple possible solutions with varying value propositions to a variety of stakeholders before determining the option that has the most value and/or impact.
d) Suspends initial judgement on new ideas	The FSE Engineer keeps an open mind when considering potential design solutions, neither discounting seemingly outlandish ideas nor embracing the most obvious ones. A Lean engineering principle is to decide as late as possible, so that more design choices are based on fact, rather than speculation.
i) focuses on understanding the value proposition of a discovery	The FSE Engineer does not ask “Can we build it?” Rather, s/he asks, “Should we build it?” This means discerning the pain points and needs of different customer segments to ensure that an innovation will add value to their lives.
k) Defines a market and market opportunities	The FSE Engineer determines the value proposition of an innovation to potential buyers, users, and/or decision-makers and understands the channels and funding streams that will move the innovation into the marketplace.
<b>ABET+EM #3</b> <b><i>The FSE Engineer can communicate effectively with diverse audiences, articulating how a discovery adds value from multiple perspectives (e.g., technological, societal, environmental, etc.).</i></b>	
m) Articulates the idea to diverse audiences.	The FSE Engineer understands that to have impact engineers have to be able to communicate the value of their work to diverse audiences. “Articulates” can refer to communication in writing, speaking, videos, social media, etc. “Diverse audiences” can refer to engineers from multiple disciplines, laypeople of all ages and levels of education, a range of professionals (CEOs, CFOs, Chief Engineers, lawyers, etc.), and people of different ethnic and cultural backgrounds, including those from other countries.
n) Persuades why a discovery adds value from multiple perspectives (technological, societal, financial, environmental, etc.).	The FSE Engineer analyzes the impacts and value of an innovation to society, communities, the environment, and other relevant areas and conveys that impact and value with data.
<b>ABET+EM #4</b> <b><i>The FSE Engineer can recognize an engineer’s ethical and professional responsibilities, understanding that potential solutions have the potential to lead to both gains and losses. Understanding how elements of an ecosystem are connected, can make informed judgements about expected and unanticipated impacts of engineering solutions in global, economic, environmental, and societal contexts.</i></b>	
l) Engages in actions with the understanding that they have the potential to lead to both gains and losses.	The FSE engineer understands that innovation involves risk. Some risk can be calculated, but sufficient information may not be available in the design phase. The FSE engineer innovates with an understanding of the potential consequences (positive and negative) of new programs and/or technologies, communicates these potential consequences to supervisors and other stakeholders, and is prepared to pivot when more information becomes available and/or unexpected and undesirable outcomes arise.
o) Understands how elements of an ecosystem are connected.	The FSE engineer considers the interdependence of technology, the environment, society, the economy, and other areas and thinks holistically about potential consequences of an innovation.

**ABET+EM #5**

***The FSE Engineer can function effectively on teams whose members have diverse and complimentary skillsets, backgrounds, and/or expertise, creating an inclusive environment characterized by shared leadership to successfully establish goals, plan tasks, and meet objectives.***

p) Identifies and works with individuals with complementary skill sets, expertise, etc

The FSE Engineer can discern colleagues' strengths and leverage those strengths into work plans to complete projects on time and with high quality.

**ABET+EM #6**

***The FSE Engineer can develop and conduct appropriate experimentation and analyze and interpret data to support and refute ideas. Can collect feedback and data from customers and/or customer segments and use engineering judgment to draw conclusions to modify an innovation accordingly.***

c) Gathers data to support and refute ideas

The FSE Engineer tests the viability of an idea using existing or generated data.

f) Collects feedback and data from many customers and customer segments.

The FSE Engineer interacts with users to learn the effects and effectiveness of a potential innovation.

h) Modifies an idea/product based on feedback.

The FSE Engineer ensures that an innovation fulfills a need and value proposition by observing/studying users' experiences with a prototype and/or existing products and iterating accordingly. "Feedback" can also refer to data collected through testing.

**ABET+EM #7**

***The FSE Engineer can seek and apply new knowledge, synthesizing information from a range of sources and/or modalities to discern trends about the changing world and adopting a future-focused perspective to assess the sustainability and/or scalability of potential solutions.***

e) Observes trends about the changing world with a future-focused orientation/perspective.

The FSE engineer asks, "What's next?", seeking new approaches to existing solutions, or new solutions to existing problems. The FSE engineer observes and attempts to anticipate technological, social, environmental, and economic trends when framing problems, designing solutions, and considering the sustainability of an innovation. Maintaining a future-oriented perspective—even in the face of deadlines and resource and budget constraints—can reveal unexpected opportunities.

j) Describes how a discovery could be scaled and/or sustained, using elements such as revenue streams, key partners, costs, and key resources.

The FSE Engineer possesses skills to assess innovations' potential sustainability and scalability.

q) Integrates/ synthesizes different kinds of knowledge.

The FSE Engineer can synthesize data from different engineering disciplines, as well as from quantitative and qualitative sources.

## ABET+EM CAC Student Outcomes x EM@FSE 2.0 Indicator Coverage—Explained

Please use this guide when planning EM coverage in your Fall 2019 and Spring 2020 course(s). EM@FSE 2.0 Indicators are grouped under the ABET+EM ("ABET Plus") Outcomes. Coverage Levels of each indicator are:

**\*Introduced**—e.g. lecture or ungraded out-of-class reading

**\*Skills Developed**—e.g. individual or group activity or ungraded assignment

**\*Assessed**—a level of performance is assessed such that the instructor can determine whether 70% of students achieved 70% or better proficiency.

This document can be accessed at [EM@FSE 2.0 Coverage Explained](#)

**Note:** *The EM@FSE initiative does not change how FSE programs cover or assess ABET 1-7 Outcomes*

EM@FSE 2.0 Indicator linked to ABET Student Outcomes	Explanation
<b>ABET+EM #1</b> <b>Can critically observe surroundings to both recognize and anticipate opportunities, then applies engineering principles, technical skills, science, and mathematics to analyze complex computing problems and identify potential solutions.</b>	
a) Critically observes surroundings to recognize opportunity	Recognizing opportunity begins with being aware of what's going on around you, noticing what is so common that we don't even think about it as well as what's strange within the ordinary. The FSE Engineer recognizes opportunities to apply engineered solutions to everything from day-to-day problems all the way up to grand challenges.
e) Observes trends about the changing world with a future-focused orientation/ perspective.	The FSE engineer asks, "What's next?" seeking new approaches to existing solutions, or new solutions to existing problems. The FSE engineer observes and attempts to anticipate technological, social, environmental, and economic trends when framing problems, designing solutions, and considering the sustainability of an innovation. Maintaining a future-oriented perspective—even in the face of deadlines and resource and budget constraints—can reveal unexpected opportunities.
g) Applies technical skills/ knowledge to the development of a technology/ product	This is ABET Student Outcome Criterion #1.
<b>ABET+EM #2</b> <b>Can apply human-centered design principles, including synthesizing different kinds of information, exploring multiple solution paths, suspending judgement on new ideas, and considering the sustainability and scalability of potential solutions in order to design, implement, and evaluate a computing-based solution that meets specified computer requirements as well as users' needs and value propositions.</b>	
b) Explores multiple solution paths	The FSE Engineer frames and reframes social and engineering problems in order to generate multiple possible solutions with varying value propositions to a variety of stakeholders before determining the option that has the most value and/or impact.
c) Gathers data to support and refute ideas	The FSE Engineer tests the viability of an idea using existing or generated data.
d) Suspends initial judgement on new ideas	The FSE Engineer keeps an open mind when considering potential design solutions, neither discounting seemingly outlandish ideas nor embracing the most obvious ones. A Lean engineering principle is to decide as late as possible, so that more design choices are based on fact, rather than speculation.
f) Collects feedback and data from many customers and customer segments.	The FSE Engineer interacts with users to learn the effects and effectiveness of a potential innovation.
h) Modifies an idea/product based on feedback.	The FSE Engineer ensures that an innovation fulfills a need and value proposition by observing/studying users' experiences with a prototype and/or existing products and iterating accordingly. "Feedback" can also refer to data collected through testing.
i) focuses on understanding the value proposition of a discovery	The FSE Engineer does not ask "Can we build it?" Rather, s/he asks, "Should we build it?" This means discerning the pain points and needs of different customer segments to ensure that an innovation will add value to their lives.
j) Describes how a discovery could be scaled and/or sustained, using elements such as revenue streams, key partners, costs, and key resources.	The FSE Engineer possesses skills to assess innovations' potential sustainability and scalability.
k) Defines a market and market opportunities	The FSE Engineer determines the value proposition of an innovation to potential buyers, users, and/or decision-makers and understands the channels and funding streams that will move the innovation into the marketplace.
q) Integrates/ synthesizes different kinds of knowledge.	The FSE Engineer can synthesize data from different engineering disciplines, as well as from quantitative and qualitative sources.
<b>ABET+EM #3</b> <b>The FSE Engineer can communicate effectively with diverse audiences, articulating how a discovery adds value from multiple perspectives (e.g., technological, societal, environmental, etc.).</b>	
m) Articulates the idea to diverse audiences.	The FSE Engineer understands that to have impact engineers have to be able to communicate the value of their work to diverse audiences. "Articulates" can refer to communication in writing, speaking, videos, social media, etc. "Diverse audiences" can refer to engineers from multiple disciplines, laypeople of all ages and levels of education, a range of professionals (CEOs, CFOs, Chief Engineers, lawyers, etc.), and people of different ethnic and cultural backgrounds, including those from other countries.
n) Persuades why a discovery adds value from multiple perspectives (technological, societal, financial, environmental, etc.).	The FSE Engineer analyzes the impacts and value of an innovation to society, communities, the environment, and other relevant areas and conveys that impact and value with data.
<b>ABET+EM #4</b> <b>Can recognize an engineer's professional responsibilities and make informed judgments in computing practice based on legal and ethical principles. Understands that potential solutions have the potential to lead to both gains and losses. Understands how elements of an ecosystem are connected, and can make informed judgements about expected and unanticipated impacts of computing solutions.</b>	
l) Engages in actions with the understanding that they have the potential to lead to both gains and losses.	The FSE engineer understands that innovation involves risk. Some risk can be calculated, but sufficient information may not be available in the design phase. The FSE engineer innovates with an understanding of the potential consequences (positive and negative) of new programs and/or technologies, communicates these potential consequences to supervisors and other stakeholders, and is prepared to pivot when more information becomes available and/or unexpected and undesirable outcomes arise.
o) Understands how elements of an ecosystem are connected.	The FSE engineer considers the interdependence of technology, the environment, society, the economy, and other areas and thinks holistically about potential consequences of an innovation.
<b>ABET+EM #5</b> <b>Can function effectively on teams engaged in activities appropriate to the engineer's discipline, whose members have diverse and complimentary skillsets, backgrounds, and/or expertise, creating an inclusive environment characterized by shared leadership to successfully establish goals, plan tasks, and meet objectives.</b>	

p) Identifies and works with individuals with complementary skill sets, expertise, etc	The FSE Engineer can discern colleagues' strengths and leverage those strengths into work plans to complete projects on time and with high quality.
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