TO: The Faculty of the College of Engineering

FROM: The Faculty of the School of Engineering Education

RE: New Undergraduate Course, ENGR 13000, Transforming Ideas into Innovations

The Faculty of the School of Engineering Education has approved the following new course. This action is now submitted to the Engineering Faculty with a recommendation for approval.

ENGR 13000 - Transforming Ideas into Innovations

Term offered: Fall, Spring, Summer Lecture and Lab, Cr. 4

Prerequisites: co-enrollment in Chem 116 or Physics 172; and instructor permission

Description: This introductory course to engineering teaches skills in managing complex problems related to design, systems analysis with computational tools, and academic and professional development. Through multiple experiences, students will learn effective methods to design and analyze behaviors of complex engineering systems with an eye for innovation. These experiences will develop their skills in teaming, project management, logical reasoning, sustainability, coupled with with oral, written and visual communication for multiple audiences. This course also develops students' ability to build computational tools (e.g. Python, MATLAB and Excel) to analyze the performance of systems using fundamental concepts associated with physical science and data science (e.g. mathematical modeling, data processing, numerical modeling, statistics).

Professional identity development is critical to preparing students for making an informed decision in their choice of major and the development of professional skills to succeed in that major. Therefore, the course includes learning experiences to help them gather and process information about all the engineering academic pathways they could choose at Purdue.

Reason: This course provides an accelerated pathway into a major for eligible first year engineering students. Many high school students accelerated their pathway into Purdue by taking advanced placement courses (e.g. physics, chemistry, statistics) and have taken part in engineering programs to increase technical skills (e.g. programming, CAD, design with teams) and their interest in engineering. Their self-selection into the accelerated pathway provides them with the opportunity to do more in four years at Purdue. This advanced pathway may provide some students a faster pathway into research opportunities, internships and early graduation.

A partial model of this course has been taught in part with the honors first year engineering course ENGR 141 – Creativity and Innovation I for 6 years (and previously as an experimental ENGR 195 course). The evaluation of student learning outcomes and impact have been positive.

Donna Riley
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ENGR 13000 – Transforming Ideas to Innovations
Credits: 4
Contact Hours: 6
Capacity: 80-120

COURSE OBJECTIVES:

This course introduces students to engineering professions through multidisciplinary, socially relevant content and action. Students will learn how to develop approaches for comprehending engineered systems coupled with generating and exploring creative ideas and alternative designs. Students will learn concepts related to design, creativity, innovation, engineering fundamentals, computational modeling and problem-solving methodologies. Through multiple experiences, they will learn effective methods to design and analyze behaviors of complex engineering systems with an eye for innovation. These experiences will develop their skills in teaming, project management, logical reasoning, sustainability, plus oral, written and visual communication. This course also develops students' ability to build computational tools (by programming with Python, MATLAB and Excel) to analyze the performance of systems using fundamental concepts associated with physical and data science (e.g. mathematical modeling, data processing, numerical modeling, statistics).

Successful completion of this course will enable students to:

1. Investigate engineering problems to reach evidence-based conclusions, drawing upon one or more sources of information and data interpretation skills including data gathering, data cleaning, regression, and statistics.
2. Plan and implement systematic design processes using formal project management and design tools such as work breakdown structures, time lines, functional block diagrams, and engineering specifications to efficiently design innovative products and systems.
3. Investigate and decompose complex systems into functional components to explain, predict and/or control the behaviors of the system.
4. Develop, test and refine devices and systems to achieve multiple technical requirements and present quantitative evidence that prove achievement of these specifications.
5. Display ability to apply mathematical and scientific knowledge and methods to model and analyze systems.
6. Apply fundamental engineering skills and knowledge involving estimation, spatial reasoning, graphical representation, units, dimensions, significant digits, and the problem presentation method associated with successful solutions to engineering challenges.
7. Work in teams consisting of diverse members to carry out complex engineering tasks. This collaborative work needs team members to be accountable to one another and learn interdependently as they manage their team process.
8. Demonstrate professional communications skills in the areas of technical writing, oral presentations, and interpersonal communication to produce evidence-based engineering reports. These reports will convey engineering findings and evidence using written, verbal, and graphical methods to effectively support the audience's comprehension of the major message.

9. Generate programming-language-independent system charts and flow diagrams embodying those algorithms for data processing, knowledge generation and system modeling.
10. Translate algorithms into computational models using basic programming constructs, such as, data structures, conditionals, repetition structures, function and file input/output.
11. Use multiple programming environments to implement algorithms using basic programming constructs of several languages (e.g. Python, MATLAB (and Excel)) and coding best practices such that the resulting code is effective, well-documented, and error-free.
12. Discuss the engineering education course sequence and options at Purdue, explain and compare engineering job functions and roles, and use this information to prepare a first draft of a personal course of study for academic and career success.
13. Employ academic and career success strategies including managing your personal learning approach, using time management techniques, and seeking opportunities for self-improvement to thoughtfully pursue course activities and the course.
14. Consider and apply engineering ethics, including social, safety, and sustainability issues into instances of engineering thinking and engineering problem solving.

COURSE EXPECTATIONS:

Students are expected to:

- Be an active problem solver, contributor, and discussant in class. Be prepared and accountable for class by reading the assigned material ahead of time and be able to answer questions related to this material.
- Be held accountable for the material that is, or is not, explicitly discussed in class.
- Have a public presence in the class.
- Attend class because of a community expectation to learn from each other.
- Be cooperative with your team and work with them, not compete against them.
- Learn interdependently with your team and your peers.
- Learn to be accountable to your team and have your team accountable to you.
- Be prepared to meet with your team outside of class to complete assignments.
- Rely on your peers, as well as the instructional team, to learn the course material.

COURSE PREREQUISITES:

Enrollment in this course requires prior admission to First-Year Engineering and advance preparation in math, science, engineering and/or computer science. This advanced preparation could be in relevant Advanced Placement (AP) courses, participation in engineering programs (e.g. PLTW, STEP, and immersive engineering outreach programs) or potentially passing an eligibility assessment. Students must be co-enrolled in either Physics 172 and/or Chem 116.

COURSE GRADE COMPUTATION:

These course deliverables are a combination of both individual and team performance.
Measures of Individual Performance (target to be >= 70%)

Team Performance	
Project 1 - Team Building	2%
Project 2 - Python Model	10%
Project 3 - Innovation Projects	10%
Design Challenges/Labs	2%
Individual Performance	
Pre-Class Quizzes (PCQ: 20/24 - drop 2)	5%
Test Your Knowledge Quizzes (TYK: highest 6 out of 7)	15%
Concept Quizzes (CQ: highest 5 out 6)	26%
Engineering Your Major Assignment (EYM)	5%
Assignments	20%
Engagement/Participation	5%
Total	100%

[+] See the section "ENGINEERING YOUR MAJOR" assignment below for more details.

COURSE GRADE COMPUTATION NOTES:
This course will make extensive use of student teams. As such, homework, activities, Quizzes (PCQ, TYK and CQ) and project grades may reflect some combination, in part or, of student's individual effort and teamwork. Exam grades will, in their entirety, represent their individual understanding of the course material. In general, your final course grade will consist of no less than 70% of your own individual contributions.

The following grading scale will be used to determine student's semester course grade:

90%≤A<100%, 80%≤B<90%, 70%≤C<80%, 60%≤D<70%, and F<60%

Students are, in the minimum, guaranteed a letter grade for the course that corresponds to their course grade percentage as determined by the course grade computation (see above).

Consistent with the policies described below, please be aware that failure to pass the "Engineering Your Major" (EYM) assignment will result in your course letter grade being lowered or receiving a letter grade of F if it is not turned in, regardless of your current numeric score.

ENGINEERING YOUR MAJOR (EYM) Assignment:

The Engineering Your Major (EYM) assignment will help a new engineering student develop an informed decision about which major they will pursue at Purdue. The assignment will consist of a report presenting the results of their research into at least three of their top choices of major they are considering. This research will include their personal reflection of their career goals and the key knowledge and skills they find necessary to achieve this goal.

They must explicitly define the general pathway through courses in these schools and how these schools will help them achieve their goals. Students will need to participate in various learning activities to learn more about the school (e.g. view videos provided by school and attending open house functions offered by the schools). These experiences could include, videos from the various schools, guest lectures, or outreach events at the various schools. Other opportunities could include University and College of Engineering (CoE) sponsored events.

Tentative Schedule –

Week	Topic Description
1	Course overview and Design Challenge 1
	Images of Engineering and Ethics
	Teams and Teaming CoC
2	Analyzing system performance with data (Intro to EXCEL)
	Systems thinking and functional block diagrams
	Flowcharting and algorithm design
3	EXCEL Part 2 - Plotting
	Design Models and Process
	Project 1 reflection -Problem Solving - Estimation and Validations (Modeling)
4	CQ1 - Finding goals, Requirements, Specifications
	Python 1 - Introduction to programming and Python
	Design Challenge 2
5	DC 2 Reflection and Design Management (Project management Project 3 design review)
	Python 2 - Data Collection Types/Conditionals
	Microcontroller Introduction Lab - Innovative thinking - Brainstorming
6	Innovation: Brainstorming and Morphological Analysis
	Python 3 - Loops and user defined functions
	Design Lab with physical devices
7	**CQ2 – Evidence Based Design (QFD)**
	Python 4 – File I/O - Plotting
	microcontroller Lab – Data Acquisitions system
8	October Break
	Evidence Based Design (QFD)
	CAD
9	Introduce Project 2: Computational Modeling Project 2 (Numerical Analysis)
	Data Cleaning
	Representing data (Methods of selected points)
10	Linear systems/ Method of Least Squares
	Non-Linear Systems/Goodness of fit
	Project 2 work day

Week	Topic Description
11	Project 2 - presentations
	MATLAB 1 Introduction
	Design Challenge 3
12	DC3 – Reflection Introduction to STATS - reasoning with data Normal Distribution, Histogram
	Descriptive Stats
13	Project 3 work day
	MATLAB 2 - Arrays, Data Load, and Plotting (histograms)
	Descriptive STATS - standard normal distribution
14	MATLAB 3 - Conditionals and loops
	Thanksgiving
15	Stats Practice day
	MATLAB 4 - File IO
	Project 3 work day
16	Project 3 Demonstration – Tech Fair
	Project 3 Presentation
	Adjournment - Project 3 report due