PROJECT-ENHANCED LEARNING IN STEM EDUCATION

THREE EXAMPLES FROM ENGINEERING

Course	**Proposed project**	**New concepts applied**	**Assessment tools**
ME 200 Thermodynamics	Residential heating and cooling system design and evaluation	1st and 2nd laws, open and closed systems, entropy, heat	Final exam. Project report, presentation, concept map exercises.
ME 274 Dynamics	Racecar dynamics, car and track design	Kinematics and Kinetics of a race car; Newton's 2nd Law of motion.	Final Exam, Tests and Project report, presentation, concept map exercises.
ECE 302 Engineering Probability & Statics	Digital communication receiver, disk access system	Sample space, outcomes, the axioms of probability, conditional probability, Baye's Theorem	Final Exam, Simulation program design, project report, presentation, concept map exercises.

ME 200 Thermodynamics

COURSE OUTCOME	PROJECT TASK
Explain the concepts of equilibrium, temperature, property, state, and thermodynamic system.	Identification of system boundaries
Apply the 1st law of thermodynamics to closed systems.	Energy balance for heater and air-conditioner
Apply the 1st law of thermodynamics to open systems using a control volume analysis.	Energy balance for house
Compare the calculated, measured, or claimed performance of power cycles and refrigeration cycles with the ultimate limits of efficiency or COP imposed by the 2nd law.	Estimation of heat pump and air-conditioner COP by comparing manufacturer rating with Carnot cycle trend
Work in a team to complete a basic design project utilizing thermodynamics.	All tasks

Simplify, focus on what you want students to learn in your course. Parameters whose estimation is beyond the scope of a thermodynamics course, such as the infiltration, the heat loss from the walls and roofs were given to students, and kept as realistic as possible. The project details and the data were posted early in the semester and the students were made aware that the project work was an important part of their assessment. The different topics such as first law, second law, heat pump and refrigeration cycles were covered in sequence in the lecture portion of the course while the discussions on the project were carried out online.

Promote ownership. Students chose their own teammates and choice of a US state location. In any project-driven learning approach student ownership of the problem is an important first step. In this implementation it was observed that the students were excited to pick a state for their analysis and sometimes came up with their own team names thus indicating their taking ownership of the project.

Promote interaction. The students were asked to use the online discussion forum to post any questions / comments or interacted with the instructor during office hours regarding their project.

ECE 302 Project: Digital Communication Receiver

COURSE OUTCOME	PROJECT TASK
Solve simple probability problems in electrical and computer engineering applications.	Steps 1-6 involve the tasks of computation and analysis of the probability that the communication signal is transmitted. They also offer practical interpretation and simulation to see how key concepts, such as conditional probability and Baye's Theorem can be applied to solve engineering problems
Model complex families of signals by means of random processes.	Step 7 considers random processes to model the signal being transmitted and the task is to design the receiver for different random signals modeled by different random processes.
Determine the random process model for the output of a linear system when the system and input random process models are known.	The task in Step 8 is to estimate the random signal passing a filter and study its output behavior

ME 274 Dynamics Project: Racecar and Racetrack Design

COURSE OUTCOME	PROJECT TASK
Kinematics of particles in rectilinear and curvilinear motion.	Kinematics and kinetics for point mass systems.
Work and energy, definition of potential energy for a conservative force system.	Use of various coordinate systems for analysis of a single particle.
Apply Newton's second law of motion, energy and momentum methods.	Derivation of fundamental equations.
Systems of particles, kinematics and plane motion of rigid bodies, forces and accelerations, energy and momentum methods.	Compare performance of race cars under different conditions and impact of track conditions and interaction with other cars e.g. during collisions.
Work in a team to complete a basic design project utilizing dynamics laws and principles.	All tasks