MATH 131 – Mathematics for Sustainability

Course Description from Bulletin: The course provides students with the mathematical background and quantitative reasoning skills necessary to engage as informed citizens in discussions of sustainability related to climate change, resources, pollution, recycling, economic change, and similar matters of public interest. Introduces mathematical modeling techniques with examples related to environmental and economic sustainability. Emphasis is placed on quantitative reasoning, visualization of mathematical concepts and effective communication, both verbally and textually, through writing projects that require quantitative evidence to support an argument, classroom activities, and group work. Topics range from probability, statistics, decision theory, graph theory, physics, modeling, and algebra. (3-0-3) (C)

Enrollment: This course serves as partial fulfillment of IIT's general education requirement in mathematics. It does not count toward any mathematics requirements in business, computer science, engineering, mathematics, or natural science degree programs.

Textbook(s): Roe, deForest, and Jamshidi, *Mathematics for Sustainability*, 1st ed., Springer, 2018

Other required material: None

Prerequisites: None

Objectives:

Students will be able to

1. interpret measurements and figures in the context of everyday life.
2. construct reasonable estimates for unknown amounts using orders of magnitude.
3. recast descriptions of processes using as stocks, flows, or stock-flow models.
4. calculate energy and efficiency and/or interpret energy efficiency information.
5. describe and explain the greenhouse gas effect.
6. define a network and use networks to describe some social behaviors.
7. use growth models to describe long-run trends of stock flow systems.
8. define and describe tipping points.
9. analyze and use probabilities and statistics to assess uncertainty and risk.
10. perform cost-benefit analyses and ethical considerations to choose between different decisions.

Lecture schedule: Two 75 minute lectures per week

Course Outline: Hours (37.5)

Measuring 3.75
- Representing information by numbers
- Problems of measurement (e.g. precision)
- Units
- Estimation

Flowing 7.5
- Building and analyzing stock-flow models
- Calculations using units of energy and power
- Dynamic equilibria in stock-flow systems
- The energy balance of the earth-sun system
- The greenhouse effect

Connecting 7.5
- Networks
- The bystander effect
- Feedbacks in stock-flow models

Changing 7.5
- Out-of-equilibrium stock-flow systems
- Exponential models
- Stability of equilibria in stock-flow systems
- Sensitivity of equilibria to changes in a parameter
- Tipping points in stock-flow models

Risking 7.5
- Probability
- Expectation
- Bayesian inference
- Risk vs uncertainty

Deciding 3.75
- Discounting
- Uses and limitations of cost-benefit analysis
- Introduction to game theory and the tragedy of the commons
- Market-based mechanisms for pollution abatement
- Ethical considerations

Assessment:		
	Online Quizzes/Homework	20-30%
	In-Class Activities	10-25%
	Projects	20-40%
	Final Exam	10-25%

Syllabus Prepared by: Sara Jamshidi Zelenberg and Michael Pelsmajer
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