ENGR305-H01
Fundamentals of Innovation Theory and Practice

Course: ENGR-30500-H01 "Fundamentals of Innovation Theory and Practice"

Credits: 3 credit hours

Meeting time: M: 5:30 – 6:20 pm; W: 5:30 – 7:20 pm

Location: HAMP 1252

Brightspace: https://purdue.brightspace.com

Prerequisite: None

Description: This course introduces students to opportunities to employ rigorous methods to enhance their creativity, responsiveness to stakeholder needs, and efforts to design and successfully pursue new ideas drawing on insights from diverse fields. Emphasis is placed on treating innovation as a discipline that has shifted along a spectrum from serendipity to science, and now involves formalized pattern recognition in which a practitioner may learn to routinely employ best practices that increase the probability of achieving a high impact outcome from their efforts. The course content supports Purdue's initiative to develop the Engineer of 2020 Target Attributes of innovativeness, adaptability to change, and design with awareness for perspectives spanning engineering, business, and society, among others, helping to fulfill the College's vision to prepare Purdue engineers for leadership roles in the 21st century.

This course serves as a required entry course for the College of Engineering Minor in Innovation and Transformational Change.

Objectives: Upon successful completion of this course, students will be able to:
1. Develop working knowledge of established innovation forms and motifs
2. Demonstrate ability to link innovation motifs to specific classes of problems
3. Understand, and be able to pursue, the core aspects of an end-to-end innovation process
4. Recognize the mental models, mindsets and behaviors of innovators
5. Gain awareness of the approaches various forms of organizations take to systematically innovate
6. Acquire leadership and communication skills through teamwork, oral presentations, and written deliverables

Alignment with standards:

ABET Standard	Corresponding Course Content
A. Ability to apply mathematics, science and engineering principles	Individual and team working exercises involving analogical reasoning and design to explore solutions to real-world problems; lectures on design thinking and systems thinking
B. Ability to design and conduct experiments, as well as to analyze and interpret data	Team working exercises involving designing and iteratively exploring assumptions underlying potential solutions to real-world problems; lecture on planning-to-learn concepts
C. Ability to design a system, component, or process to meet desired needs	Team working exercises and lecture content on issue analysis and ecosystem and stakeholder exploration; team working session on systems-level solution prioritization
D. Ability to function on multidisciplinary teams	Multiple team working exercises to apply course concepts to contemporary real-world challenges
E. Ability to identify, formulate, and solve engineering problems	Lectures on problem framing, hypothesis-driven problem solving, and leveraging structure and analogies to generate solutions; related working exercises
G. Ability to communicate effectively	Lecture on persuasive communications, public speaking, and managing Q&A, overview of key concepts in marketing new ideas; team oral presentations and individual and team written assignments
H. The broad education necessary to understand the impact of engineering solutions in a global and societal context	Team working exercises to explore contemporary socio-technical challenges at a systems level; course content, and deliverables centered around design and innovation that encompass the full breadth of functional, social and emotional factors likely to shape a solution's design, use and adoption
J. Knowledge of contemporary issues	Lectures on opportunity identification and multiple innovation case discussions
K. Ability to use the techniques, skills, and modern engineering tools necessary for engineering practice	Lecture and assignments on issue analysis, identifying barriers to uncover paths to opportunity, analogical reasoning, and right-sizing solutions

Instructor: Professor Joe Sinfield
Office: HAMP G231
Phone: 765-496-2742
E-mail: jvs@purdue.edu

Grading:

Weight	Activity
55%	Team Working Exercises: Students in the class divide into teams of 3 to 5 to apply specific innovation concepts, such as issues analysis, ecosystem definition, empathy driven stakeholder profiling, analogical solution development, and assumption analysis to a variety of contemporary real world challenges in weekly working exercises. Team composition and problem focus is varied throughout the semester. A portion of team grades will be linked to participation and peer evaluation.
30%	Homework: Brief individual written assignments are employed to guide students through exploration of course concepts (typically 4-6 assignments).
15%	Quizzes and/or Cases: In-class quizzes and/or take home case exercises are used to demonstrate student understanding of discussed innovation principles (typically 2-4 quizzes/cases).

Learning resources:

Textbook: None

Brightspace: Brightspace will be used to provide access to all course lecture content, and may also be used to manage some course learning evaluation mechanisms (e.g., homework, quizzes or exams) [https://purdue.brightspace.com]

Assignments: No assignments can be missed without penalty, unless the missed assignment is authorized by the instructor. Assignment due dates/times will posted with each assignment.

Attendance: Student attendance at in-person sessions is desirable but not mandatory. Students should stay home and contact the Protect Purdue Health Center (496-INFO) if they feel ill, have any symptoms associated with COVID-19, or suspect they have been exposed to the virus. In the current context of COVID-19, in-person attendance will not be a factor in the final grades, but the student still needs to inform the instructor of any conflict that can be anticipated and will affect the submission of an assignment or the ability to take an exam. Only the instructor can excuse a student from a course requirement or responsibility. When conflicts can be anticipated, such as for many University-sponsored activities and religious observations, the student should inform the instructor of the situation as far in advance as possible. For unanticipated or emergency conflict, when advance notification to an instructor is not possible, the student should contact the instructor as soon as possible by email, through Brightspace, or by phone. When the student is unable to make direct contact with the instructor and is unable to leave word with the instructor's department because of circumstances beyond the

student's control, and in cases of bereavement, quarantine, or isolation, the student or the student's representative should contact the Office of the Dean of Students via email or phone at 765-494-1747. Our course Brightspace includes a link on Attendance and Grief Absence policies under the University Policies menu.

Guidance in the event of quarantine/ isolation:

If you become quarantined or isolated at any point in time during the semester, in addition to support from the Protect Purdue Health Center, you will also have access to an Academic Case Manager who can provide you academic support during this time. Your Academic Case Manager can be reached at acmq@purdue.edu and will provide you with general guidelines/resources around communicating with your instructors, be available for academic support, and offer suggestions for how to be successful when learning remotely. Importantly, if you find yourself too sick to progress in the course, notify your academic case manager and notify me via email or Brightspace. We will make arrangements based on your particular situation. The Office of the Dean of Students (odos@purdue.edu) is also available to support you should this situation occur.

Classroom Guidance Regarding Protect Purdue:

The Protect Purdue Plan, which includes the Protect Purdue Pledge, is campus policy and as such all members of the Purdue community must comply with the required health and safety guidelines. Required behaviors in this class include: staying home and contacting the Protect Purdue Health Center (496-INFO) if you feel ill or know you have been exposed to the virus, properly wearing a mask in classrooms and campus building, at all times (e.g., mask covers nose and mouth, no eating/drinking in the classroom), disinfecting desk/workspace prior to and after use, maintaining appropriate social distancing with peers and instructors (including when entering/exiting classrooms), refraining from moving furniture, avoiding shared use of personal items, maintaining robust hygiene (e.g., handwashing, disposal of tissues) prior to, during and after class, and following all safety directions from the instructor.

Students who are not engaging in these behaviors (e.g., wearing a mask) will be offered the opportunity to comply. If non-compliance continues, possible results include instructors asking the student to leave class and instructors dismissing the whole class. Students who do not comply with the required health behaviors are violating the University Code of Conduct and will be reported to the Dean of Students Office with sanctions ranging from educational requirements to dismissal from the university.

Any student who has substantial reason to believe that another person in a campus room (e.g., classroom) is threatening the safety of others by not complying (e.g., not wearing a mask) may leave the room without consequence. The student is

encouraged to report the behavior to and discuss next steps with their instructor. Students also have the option of reporting the behavior to the Office of the Student Rights and Responsibilities. See also Purdue University Bill of Student Rights.

Academic integrity:

Students are expected to uphold all university policies and regulations on academic integrity and conduct. Academic dishonesty will not be tolerated, and any acts of academic dishonesty will be dealt with on a case by case basis. Penalties for violations will be levied at the discretion of the instructor and may include but are not limited to reduction in the grade received for an assignment or exam, loss of credit for an assignment or exam, reduction in the FINAL grade for the course, and/or failure of the course.

The University Senate has stipulated that:
"the commitment of acts of cheating, lying, and deceit in any of their diverse forms (such as the use of substitutes for taking examinations, the use of illegal cribs, plagiarism, and copying during examinations) is dishonest and must not be tolerated. Moreover, knowingly to aid and abet, directly or indirectly, other parties in committing dishonest acts is in itself dishonest" [University Senate Document 72-18].

Students are reminded of the Purdue Honor Pledge: "As a boilermaker pursuing academic excellence, I pledge to be honest and true in all that I do. Accountable together - we are Purdue."

Academic integrity is one of the highest values that Purdue University holds. Individuals are encouraged to alert university officials to potential breeches of this value by either emailing integrity@purdue.edu or by calling 765-494-8778. While information may be submitted anonymously, the more information that is submitted provides the greatest opportunity for the university to investigate the concern.

For further information note that Brightspace includes a link to Purdue's Student Guide for Academic Integrity under University Policies.

Use of copyrighted works:

Students are expected, within the context of the Regulations Governing Student Conduct and other applicable University policies, to act responsibly and ethically by applying the appropriate exception under the Copyright Act to the use of copyrighted works in their activities and studies.

Class notes in any form are "considered to be 'derivative works' of the instructor's presentations and materials, and they are thus subject to the instructor's copyright in such presentations and materials." As such, they cannot be sold or bartered without the instructor's express written permission. For further details on related University policy, (see part J of the Purdue student miscellaneous conduct regulations).

The University does not assume legal responsibility for violations of copyright law by students who are not employees of the University.

Behavior: Disruptive behavior will not be tolerated. You may be asked to leave class. Examples include: arriving late, talking during lecture, making inappropriate comments, sleeping, leaving early, engaging in activities not related to class (e.g. texting, other homework).

Nondiscrim-ination Statement: Purdue University is committed to maintaining a community which recognizes and values the inherent worth and dignity of every person; fosters tolerance, sensitivity, understanding, and mutual respect among its members; and encourages each individual to strive to reach his or her own potential. In pursuit of its goal of academic excellence, the University seeks to develop and nurture diversity. The University believes that diversity among its many members strengthens the institution, stimulates creativity, promotes the exchange of ideas, and enriches campus life. More details are available on our course Brightspace table of contents, under University Policies.

Accessibility: Purdue University strives to make learning experiences as accessible as possible. If you anticipate or experience physical or academic barriers based on disability, you are welcome to let me know so that we can discuss options. You are also encouraged to contact the Disability Resource Center at: drc@purdue.edu or by phone: 765-494-1247. More details are available on our course Brightspace under Accessibility Information.

Mental Health Statement: **If you find yourself beginning to feel some stress, anxiety and/or feeling slightly overwhelmed, try WellTrack.** Sign in and find information and tools at your fingertips, available to you at any time.

If you need support and information about options and resources, please contact or see the Office of the Dean of Students. Call 765-494-1747. Hours of operation are M-F, 8 am- 5 pm.

If you find yourself struggling to find a healthy balance between academics, social life, stress, etc. sign up for free one-on-one virtual or in-person sessions with a Purdue Wellness Coach at RecWell. Student coaches can help you navigate through barriers and challenges toward your goals throughout the semester. Sign up is completely free and can be done on BoilerConnect. If you have any questions, please contact Purdue Wellness at evans240@purdue.edu.

If you're struggling and need mental health services: Purdue University is committed to advancing the mental health and well-being of its students. If you or

someone you know is feeling overwhelmed, depressed, and/or in need of mental health support, services are available. For help, such individuals should contact Counseling and Psychological Services (CAPS) at 765-494-6995 during and after hours, on weekends and holidays, or by going to the CAPS office of the second floor of the Purdue University Student Health Center (PUSH) during business hours.

Counseling: Purdue University is committed to advancing the mental health and well-being of its students. If you or someone you know is feeling overwhelmed, depressed, and/or in need of support, services are available. For help, such individuals should contact Counseling and Psychological Services (CAPS) at (765) 494-6995 and http://www.purdue.edu/caps/ during and after hours, on weekends and holidays, or through its counselors physically located in the Purdue University Student Health Center (PUSH) during business hours.

Emergency preparation: In the event of a major campus emergency, course requirements, deadlines and grading percentages are subject to changes that may be necessitated by a revised semester calendar or other circumstances beyond the instructor's control. Relevant changes to this course will be posted onto the course website or can be obtained by contacting the instructors or TAs via email or phone. You are expected to read your @purdue.edu email on a frequent basis.

EMERGENCY NOTIFICATION PROCEDURES are based on a simple concept – if you hear a fire alarm inside, proceed outside. If you hear a siren outside, proceed inside.

Indoor Fire Alarms mean to stop class or research and immediately **evacuate** the building.
Proceed to your Emergency Assembly Area away from building doors. **Remain outside** until police, fire, or other emergency response personnel provide additional guidance or tell you it is safe to leave.

All Hazards Outdoor Emergency Warning Sirens mean to immediately seek shelter (**Shelter in Place**) in a safe location within the closest building.

"Shelter in place" means seeking immediate shelter inside a building or University residence. This course of action may need to be taken during a tornado, a civil disturbance including a shooting or release of hazardous materials in the outside air. Once safely inside, find out more details about the emergency*. **Remain in place** until police, fire, or other emergency response personnel provide additional guidance or tell you it is safe to leave.

*In both cases, you should seek additional clarifying information by all means possible…Purdue Home page, email alert, TV, radio, etc…review the Purdue Emergency Warning Notification System multi-communication layers at http://www.purdue.edu/ehps/emergency_preparedness/warning-system.html

EMERGENCY RESPONSE PROCEDURES:
• Review the **Emergency Procedures Guidelines**
https://www.purdue.edu/emergency_preparedness/flipchart/index.html
• Review the **Building Emergency Plan** (available from the building deputy) for:
o evacuation routes, exit points, and emergency assembly area
o when and how to evacuate the building.
o shelter in place procedures and locations
o additional building specific procedures and requirements.

MORE INFORMATION
Reference the Emergency Preparedness web site for additional information:
http://www.purdue.edu/emergency_preparedness

Course outline:

Week*	Topic		Reading/References
1	I.	Achieving leadership through innovation	
2, 3	II.	Innovation motifs – linking design approaches to context	Solis and Sinfield 2017
4	III.	Design and the novice to expert continuum; beyond design thinking	Crismond and Adams, 2012; Brown and Wyatt, 2010
4, 5	IV.	The high-impact enabling innovation model	Sinfield and Solis, 2016a; Sinfield and Solis, 2016b; Solis and Sinfield, 2014
5, 6	V.	Framing a problem: Issue analysis and hypothesis-driven problem solving	Minto, 1996
7	VI.	Ecosystem and stakeholder exploration	Belone et al., 2016; Anthony et al., 2007 (Beebe, 2014- reference)
7, 8	VII.	Systems thinking in socio-technical contexts	DeLaurentis and Callaway, 2004; Mostafavi et al., 2011 (Gorod, et al., 2008-reference)
9, 10	VIII.	End-user understanding	Anthony et al. 2008 (Ch. 4)
11, 12	IX.	Analogical reasoning and systematic methods of solution space development	Gick and Holyoak, 1980
13	X.	Engagement / involvement strategy	
13, 14	XI.	Solution economics	Weill et al. 2004; Sinfield et al. 2012; Giddings et al., 2002
14, 15	XII.	Planning to learn	McGrath and MacMillan 1995
15	XIII.	Persuasive communications, public speaking, and managing Q&A	Bacon, 1996
16	XIV.	Innovator attributes and best practices	Sinfield and Anthony, 2006; Sinfield et al., 2014; Girotra et al., 2010; Solis and Sinfield, 2016; Solis and Sinfield, 2017

*Schedule is approximate and will be adjusted based on class engagement and progress.

Reading list: Readings will be drawn from the following references

1. Anthony, S.D., Johnson, M.W., Sinfield, J.V., Altman, E.J., **The Innovator's Guide to Growth–Putting Disruptive Innovation to Work**, Harvard Business Press, 2008, 299 p.
2. Bacon, Terry R., "Interpersonal and Interactive Skills", Lore Innovation Institute, McKinsey & Company, 1996.
3. Gick, M.L. and Holyoak, K. J. (1980) "Analogical Problem Solving," Cognitive Psychology, (12), 3, 306-355.
4. Giddings, B., Hopwood, B., and O'Brien, G. (2002). "Environment, economy, and society: Fitting them together into sustainable development," Sustainable Development, (10), 2, 187–196
5. Anthony, S. D., and Sinfield, J.V. (2007) "Product for Hire: Master the Innovation Lifecycle with a Jobs-to-be-Done Perspective of Markets,"*Marketing Management*, March/April, 19-24.
6. Beebe, J. (2014). **Rapid Qualitative Inquiry: A Field Guide to Team-Based Assessment**, Second Edition. Lanham MD: Rowman & Littefield. 258 pp.
7. Belone, L., Lucero, J.E., Duran, B., Tafoya, G., Baker, E.A., Chan, D., Chang, C. Greene-Moton, E., Kelley, M. A., and Wallerstein, N., (2016). "Community-Based Participatory Research Conceptual Model: Community Partner Consultation and Face Validity," *Qualitative Health Research*, 26(1): 117-135.
8. Brown, T., and Wyatt, J. (2010), "Design Thinking for Social Innovation," *Development Outreach,* (12)1, 29-43.
9. Crismond, D. P., and Adams, R. S. (2012). "The Informed Design Teaching and Learning Matrix." *Journal of Engineering Education*, 101(4), 738-797.
10. DeLaurentis, D., & Callaway, R. (2004). "A systems-of-systems perspective for public policy decisions." *Review of Policy Research*, 21(6), 9.
11. Girotra, K., Terwiesch, C., and Ulrich, K. T., (2010) "Idea Generation and the Quality of the Best Idea", *Management Science*, Vol. 56, No. 4 (April 2010), pp. 591-605.
12. Gorod, A., Sauser, B., and Boardman, J. (2008) "System-of-Systems Engineering Management: A Review of Modern History and a Path Forward," *IEEE Systems Journal*, (2) 4, 484-499.
13. McGrath, R., and MacMillan, I. (1995). "Discovery-driven planning." *Harvard Business Review*, 73(4), 44-54.
14. Minto, B. (1996) **The Minto Pyramid Principle: Logic in Writing, Thinking, and Problem Solving**, Minto International, Inc., London.
15. Mostafavi, M., Abraham, D., DeLaurentis, D., and Sinfield, J. (2011). "Exploring the Dimensions of Systems of Innovation Analysis: A System of Systems Framework." *IEEE Systems Journal,* 5(2), 256 - 265.
16. Sinfield, J. and Anthony, S. (2006) "Constraining Innovation: How Developing and Continually Refining Your Organization's Goals and Bounds Can Help Guide Growth", *Strategy & Innovation*, November – December, v. 4, n. 6, 1, 6-9.
17. Sinfield, J.V., and Solis, F., (2016a) "Finding a Lower-risk Path to High-impact Innovations," *Sloan Management Review*, 79-89, Summer.
18. Sinfield, J.V., and Solis, F., (2016b) "Thinking Big to Address Major Challenges: Design and Problem-Solving Patterns for High-Impact Innovation, National

Academy of Engineering, *The Bridge*, 11-18, Summer.

19. Sinfield, J.V., Calder, E.S., Colson, S., McConnell, B., (2012) "How to Identify New Business Models," *Sloan Management Review*, v. 53, n. 2, Winter.

20. Sinfield, J.V., Gustafson, T., and Hindo, B. (2014) "The Discipline of Creativity," *Sloan Management Review*, 55(2), 24-26, Winter.

21. Solis, F. and Sinfield, J.V. (2014) "Rethinking Innovation: Characterizing Dimensions of Impact," ASEE Annual Conference, 360 Degrees of Engineering Education, June 15 - 18, 2014 Indianapolis, Indiana, Paper ID #9284.

22. Solis, F., and Sinfield, J.V., (2016) "From Entrepreneur to Designer: The Transferable Design Principles of the Entrepreneur," (2016) ASEE Annual Conference & Exposition, Jazzed about Engineering Education, June 26-29, 2016, New Orleans, LA, Paper ID#15965.

23. Weill, P., Malone, T. W., D'Urso V.T., Herman, G. and Woerner S. (2004) "Do Some Business Models Perform Better Than Others?" MIT Sloan School of Management Working Paper/ MIT Center for Coordination Science Working Paper No. 226, 6 May.

24. Solis, F., and Sinfield, J.V., (2017). "Designing for Big X: Characterizing Design for Major Challenges," (2017). Clive L. Dym Mudd Design Workshop: Design and the Future of the Engineer of 2020, Claremont, CA.