To: The Faculty of the College of Engineering

From: The Curriculum Committee of the Innovation and Leadership Studies Program

RE: New Undergraduate Course, ENGR 30500 Fundamentals of Innovation Theory and Practice

The Curriculum Committee of the Innovation and Leadership Studies Program has approved the following new course. This action is now submitted to the Engineering Faculty with a recommendation for approval.

ENGR 30500 Fundamentals of Innovation Theory and Practice
Sem. 1, Lecture 3, Cr. 3
Prerequisites: None

Description: This course is designed to provide students with initial exposure to the fundamental patterns, mindsets, behaviors, attributes, tools, and methods employed in the innovative activity of individuals and organizations. Emphasis is placed on understanding and effectively utilizing techniques to systematically drive innovation that are drawn from the fields of business, design, problem-solving, engineering, and the social sciences. Lecture, in-class small group activities, and individual and team assignments are employed across an array of contemporary socio-technical challenges to provide students with the opportunity to apply conveyed theory and methods to rigorously structure problems, understand involved stakeholders, utilize innovation motifs and analogical reasoning to develop robust views of potential solutions spaces, tailor solution design to stakeholder context, consider the full suite of functional, social, and emotional dimensions that could influence solution prioritization, and document and systematically assess underlying solution assumptions to iterate toward a viable and sustainable forward looking plan that could achieve target outcomes.

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

Reason: Innovation is the source of leadership in many domains, driving differentiated competitive advantage in industry, providing the basis of thought leadership and scholarly excellence in academia, and potentially holding the key to sustainable solutions to an array of intractable problems pursued in the non-profit sector. Over the last 40 years, innovation has shifted along a spectrum from art to science and is increasingly recognized as a discipline involving 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. With this in mind, 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, thus

supporting 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.

This course has been offered once as an ENGR29700 course, with the following enrollment: S17 (7).

Director of Innovation and Leadership Studies_

ENGR305
Fundamentals of Innovation Theory and Practice

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

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 art 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.

Pre-requisites: None

Instructor: Professor Joe Sinfield **Office:** HAMP G231 **Phone:** x6-2742

Class hours: Two meetings per week: (1) 50 min + (1) 110 min

Classroom: TBD

Learning outcomes: 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

Relation to Engineer of 2020 Target Attributes

Target Attribute	***Corresponding Course Content***
Teamwork	Multiple team based working exercises to explore contemporary socio-technical challenges and apply innovation methodologies
Communication	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
Decision-making ability	Lecture and team working session on systems-level solution prioritization
Synthesize engineering, business, and societal perspectives	Lectures, as well as team and individual assignments, on innovation forms and motifs, ecosystem analysis, issue analysis, and systems thinking
Analytical skills	See ABET standard A, B, C and E
Open-ended design and problem solving skills	Lectures and team working exercises on problem framing and hypothesis-driven problem solving to structure ambiguity in multi-faceted real-world challenges
Multidisciplinarity within and beyond engineering	Team working exercises on contemporary challenges encompassing functional, social and emotional factors likely to shape a solution's design, use and adoption
Integration of analytical, problem solving, and design skills	Team working exercises to explore and posit solutions to contemporary socio-technical challenges; lectures on issue analysis, hypothesis driven problem solving, design thinking, systems analysis, right sizing

	solutions, and systems level prioritization
Innovative mindset	Lecture on forms of innovation and impact; case studies illustrating innovation forms and motifs and innovator behaviors and attributes
Adaptability in a changing environment	Team working sessions and lectures on ecosystem analysis
Entrepreneurial and intrapreneurial	Lecture and team working exercises on opportunity identification, stakeholder and ecosystem analysis, ideation, business model innovation and organizing to innovate

Grading:

Weight	Activity
40%	Team working exercises: Students in the class divide into teams of 3 to 4 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 (e.g., optimization of battery development, adoption of autonomous vehicles, or management of the spread of the Zika virus) in weekly working exercise. Team composition and problem focus is varied throughout the semester.
60%	Homework and cases: Brief individual written assignments are employed to guide students through exploration of course concepts and cases illustrating discussed innovation principles (typically 3-5 assignments).

Text: None

Attendance: Due to the nature of this class, class participation is a must. In order to receive course credit and a full grade, a student must:

1. Have no more than two unexcused absences.
2. Satisfactorily complete ALL assignments.

Three unexcused absences will result in a grade reduction of one letter grade. Four unexcused absences will result in a grade of 'I' or 'F', depending on whether or not the student is considered to be passing in all other aspects at the time of the fourth absence. Failure to complete ALL assignments will result in a grade of 'I' or 'F', depending on whether or not the student is considered to be passing in all other aspects.

Homework/ cases/project deliverables: No assignments can be missed without penalty, unless the missed assignment is authorized by the instructor.

Ethics: 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.

Course outline:

Week	*Topic*	*Reading/References*
1	I. Achieving leadership through innovation	
1	II. Innovation motifs – linking design approaches to context	Solis and Sinfield 2017
2	III. Design and the novice to expert continuum; design thinking	Crismond and Adams, 2012; Brown and Wyatt, 2010
3	IV. The high-impact enabling innovation model	Sinfield and Solis, 2016a; Sinfield and Solis, 2016b; Solis and Sinfield, 2014
3, 4	V. Framing a problem: Issue analysis and hypothesis-driven problem solving	Minto, 1996
5, 6	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)
8, 9	VIII. Analogical reasoning and systematic methods of solution space development	Gick and Holyoak, 1980
10	IX. 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

11,12	X.	Understanding solution economics	Weill et al. 2004; Sinfield et al. 2012
13	XI.	Solution prioritization and multi-faceted solution sustainability	Giddings et al., 2002
14	XII.	Persuasive communications, public speaking, and managing Q&A	Bacon, 1996
14, 15	XIII.	Planning to learn	McGrath and MacMillan 1995
16	XIV.	Organizing to innovate	Anthony et al. 2008 (Ch. 9)

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.

ENGR - 30500 - Fundamentals of Innovation Theory and Practice

2017-2018 Course Create New Undergraduate

General Course Information

Originating Campus*

- [x] West Lafayette
- [ ] Northwest
- [ ] Fort Wayne
- [ ] IUPUI

Non-Originating Campus(es): (Select the correct combination of additional campuses offering this course)*

- (•) No other campus involved
- ( ) West Lafayette
- ( ) Northwest
- ( ) Fort Wayne
- ( ) IUPUI
- ( ) Northwest & Fort Wayne
- ( ) Northwest & IUPUI
- ( ) West Lafayette & Northwest
- ( ) West Lafayette & Fort Wayne
- ( ) West Lafayette & IUPUI
- ( ) Fort Wayne & IUPUI
- ( ) Northwest, Fort Wayne, & IUPUI
- ( ) West Lafayette, Fort Wayne, & IUPUI
- ( ) West Lafayette, Northwest, & IUPUI
- ( ) West Lafayette, Fort Wayne, & Northwest

Multiple Campuses: There is only one version of a course in the Banner catalog. All campus locations offering this course must agree. Choosing the locations above allows all involved campuses to approve the proposal.

College/School*

College of Engineering - WL

Department*

-College of Engineering Administration (Graduate) - WL

Course Numbers: All course numbers may only be used once for a course in order to allow our repeat course audit to work properly. Before submitting a form for a new course

or renumber, please make sure the course number is available. Please remember Purdue now uses 5-digit course numbers to allow more options for the departments. This may be verified through the following:

Legacy Course Catalog: https://www.purdue.edu/registrar/legacy/catalog.cfm

Banner Course Catalog: https://selfservice.mypurdue.edu/prod/bwckctlg.p_disp_dyn_ctlg

Proposed Effective Term	Spring 2018
Proposed Subject Code*	ENGR
Proposed 5 digit course #*	30500
Long Title*	Fundamentals of Innovation Theory and Practice
Short Title (max 30 characters)	
Terms offered (Select all that apply)	☑ Fall ☑ Spring ☐ Summer

Credit Hour Guidelines: Purdue's credit hour guidelines are provided below.

http://www.purdue.edu/registrar/documents/forms/Credit_Hr_Guidelines.pdf

Please use the following two options to specify if the course credit is fixed or variable:

Option #1: Fixed Credit Hours

Proposed Credit Hours	3

Option #2: Variable Credit Range

Minimum	
Variable Credit	○ To ○ OR
Maximum	
Course Repeat Status	☐ Course may be repeated ☐ Course may not be repeated
If repeatable:	☐ Unlimited Amount of times

	☐ Maximum Repeatable Credit Amount
Maximum Credit Amount	
Grade modes (Select all that apply)	☐ Regular Grade ☐ Pass/No Pass Option ☐ Audit ☐ Satisfactory/Unsatisfactory

If this course is crosslisted, navigate to the crosslisting icon in the Proposal Toolbox.

Click on 'Add Crosslisting'
Select the proposal that has (crosslisting) after the course title
Update any fields that pertain to the crosslisted course
Save your changes
Navigate back to the Primary proposal by clicking on the 'View Primary' icon in the top left corner of the proposal

Crosslisted Course/ Equivalent Course	

Course Fees: **The following fees are provided on the form: Coop, Lab, and Rate Request. In order to ensure the accurate fee is assessed on a course, the Bursar's Office would like to have an explanation included with the form along with the business manager's contact information if additional information is needed.**

Additional Fees:	○ Yes ◉ No
Explanation of fees	
Registration Approvals	☐ Department ☑ Instructor

Attributes: (Select all that Apply)	☐ Variable Title ☐ Honors ☐ Full-Time Privileges ☐ Half-Time Privileges ☐ Internship ☐ Coop ☐ Parallel Coop ☐ Credit by Exam

Schedule Types/Credit Hours: **The following links will provide explanations of the schedule types and credit hours to assist in assigning accurate types to a course.**

Schedule Type Classifications

Credit Hour Guidelines

Use the following instructions to add each schedule type for the course in the text box. Examples are listed below.

> **Schedule Types: Lecture (LEC), Recitation (REC), Presentation (PRS), Laboratory (LAB), Lab Prep (LBP), Studio (SD), Distance Learning (DIS), Clinic (CLN), Experiential (EX), Research (RES), Individual Study (IND), Practice Study Observation (PSO)**
> **Minutes per Meeting**
> **Number of Meetings per week**
> **Weeks per term**

Examples: (3 credit course) LEC/50min per mtg/3mtgs per wk/16 wks per term OR (3 credit course with Lecture and Lab) LEC/50/2/16 and LAB/100/1/16

Proposed Schedule Type:	LEC/50min per mtg/3mtgs per wk/16 wks per term

Restrictions:

If restrictions are being requested, please provide the proper Banner codes (major, program etc.) to ensure all are accurately reflected on the course. All codes may be found on our

website under Advisors/Active PWL Major Programs, and Active PWL Minors links:

Restriction Types: major, program or school codes; never use more than one
Use the words "and" or "or" when filling out form instead of commas

Restrictions List: Department, Field of Study, Class, Level, Degree, Program, Campus, College

Proposed Restrictions:	

Requisites:

Requisite information can only be selected from active offerings.

Co-requisite courses are always required to be taken at the same time
Concurrent prerequisite courses may be taken during the same semester or in a previous term
600-level prerequisites are not enforced, they are added to description as informational text

If there is an equivalent course the department would like listed with the prerequisties, that specific course will need to be specified on the form in order to have it enforced through the system.

Pre-Requisites: D- equals the lowest passing grade, unless otherwise noted	

Co-Requisites	

Course Information:

Course Description*	This course is designed to provide students with initial exposure to the fundamental patterns, mindsets, behaviors, attributes, tools, and methods employed in the innovative activity of individuals and organizations. Emphasis is placed on understanding and effectively utilizing techniques to systematically drive innovation that are drawn from the fields of business, design, problem-solving, engineering, and the social sciences. Lecture, in-class small group activities, and individual and team assignments are employed across an array of contemporary socio-technical challenges to provide students with the opportunity to apply conveyed theory and methods to rigorously structure problems, understand involved stakeholders, utilize innovation motifs and analogical reasoning to develop robust views of potential solutions spaces, tailor solution design to stakeholder context, consider the full suite of functional, social, and emotional dimensions that could influence solution prioritization, and document and systematically assess underlying solution assumptions to iterate toward a viable and sustainable forward looking plan that could achieve target outcomes.
Learning Outcomes	Upon successful completion of this course, students will be able to: Develop working knowledge of established innovation forms and motifs Demonstrate ability to link innovation motifs to specific classes of problems Understand, and be able to pursue, the core aspects of an end-to-end innovation process Recognize the mental models, mindsets and behaviors of innovators Gain awareness of the approaches various forms of organizations take to systematically innovate Acquire leadership and communication skills through teamwork, oral presentations, and written deliverables
Additional Course Information (if needed)	

Syllabus - Attach using the directions below:

Navigate to the Proposal Toolbox at the top of the right side.

Select the "Add Files" button 

Upload file to be attached.

Validate and Launch Proposal

Once you have completed all fields:

Click “Save All Changes” 

Click on the arrow  at the top of the page to launch the proposal. (Only launch the proposal after completing all necessary fields.) The proposal will now be sent on for approvals.

WL Catalog Use Only

Catalog Ownership	
Course Type	