Engineering Faculty Document No. 78-16
March 16, 2016

To: The Faculty of the College of Engineering
From: School of Industrial Engineering, School of Aeronautics and Astronautics
Subject: New Graduate Course: IE 52000/AAE 58000

The faculty of the School of Industrial Engineering and School of Aeronautics and Astronautics have approved the following new course. This action is now submitted to the Engineering Faculty with a recommendation for approval.

Course No: **IE 52000/AAE 58000 Perspectives on Systems Engineering**
Sem. 1. Class 3, Cr. 3.
Prerequisites: Graduate Standing in Engineering or consent of instructor.

Description: This course provides an introduction to, and references for, each of four distinct approaches to Systems Engineering concepts and tools. Individual assignments and team projects will be based on readings from these multiple approaches and selected case studies. Participants will be encouraged to bring their own prior expertise and examples to the discussions and projects. While the course will discuss quantitative topics (including cybernetics, feedback control systems, and statistical process control), the course itself will emphasize a more interdisciplinary conceptual integration rather than stand-alone analysis of these topics.

Reasons: This class has been offered twice as IE/AAE 59000, with enrollments of 60 (including 34 distance) and 16 students. Planned IE and EPE Concentrations in Systems Engineering have this class as a primary required course. The course is new and reflects a unique survey of multiple definitions, approaches, and skills associated with a general study of Systems Engineering. No other course of this type exists at Purdue.

Abhijit J. Deshmukh, Professor and Head
School of Industrial Engineering

Tom Shih, Professor and Head
School of Aeronautics and Astronautics

Approved for the faculty of the Schools of Engineering by the Engineering Curriculum Committee
ECC Minutes #3 Date 10-18-16
Chairman ECC

Office of the Registrar
FORM 40G REV. 4/13

PURDUE UNIVERSITY
REQUEST FOR ADDITION, EXPIRATION,
OR REVISION OF A GRADUATE COURSE
(50000-60000 LEVEL)

PRINT

DEPARTMENT: School of Aeronautics and Astronautics
EFFECTIVE SESSION: Fall 2016

INSTRUCTIONS: Please check the items below which describe the purpose of this request.

- [x] 1. New course with supporting documents (complete proposal form)
- [ ] 2. Add existing course offered at another campus
- [ ] 3. Expiration of a course
- [ ] 4. Change in course number
- [ ] 5. Change in course title
- [ ] 6. Change in course credit/type
- [ ] 7. Change in course attributes
- [ ] 8. Change in instructional hours
- [ ] 9. Change in course description
- [ ] 10. Change in course requisites
- [ ] 11. Change in semesters offered
- [ ] 12. Transfer from one department to another

PROPOSED:		EXISTING:	
Subject Abbreviation	AAE	Subject Abbreviation	AAE
Course Number	58000	Course Number	59000
Long Title	Perspectives on Systems Engineering		
Short Title	Perspectives on Systems Engr		

Abbreviated title will be entered by the Office of the Registrar if omitted. (30 CHARACTERS ONLY)

TERMS OFFERED
Check All That Apply:
[x] Fall [ ] Spring [ ] Summer

CAMPUS(ES) INVOLVED
[ ] Calumet [ ] N. Central
[x] Cont Ed [ ] Tech Statewide
[ ] Ft. Wayne [x] W. Lafayette
[ ] Indianapolis

CREDIT TYPE
1. Fixed Credit: Cr. Hrs. 3
2. Variable Credit Range:
Minimum Cr. Hrs
(Check One) To [ ] Or [ ]
Maximum Cr. Hrs
3. Equivalent Credit: Yes [ ] No [x]
4. Thesis Credit: Yes [ ] No [x]

COURSE ATTRIBUTES: Check All That Apply
1. Pass/Not Pass Only [ ]
2. Satisfactory/Unsatisfactory Only [ ]
3. Repeatable [ ]
Maximum Repeatable Credit: [ ]
4. Credit by Examination [ ]
5. Fees [ ] Coop [ ] Lab [ ] Rate Request [ ]
Include comment to explain fee
6. Registration Approval Type
Department [ ] Instructor [ ]
7. Variable Title [ ]
8. Honors [ ]
9. Full Time Privilege [ ]
10. Off Campus Experience [ ]

Schedule Type	Minutes Per Mtg	Meetings Per Week	Weeks Offered	% of Credit Allocated
Lecture	150	2	15	100
Recitation				
Presentation				
Laboratory				
Lab Prep				
Studio				
Distance				
Clinic				
Experiential				
Research				
Ind. Study				
Pract/Observ				

Cross-Listed Courses
IE 52000

COURSE DESCRIPTION (INCLUDE REQUISITES/RESTRICTIONS):

See supporting docmuments

*COURSE LEARNING OUTCOMES:

see attached documents

Calumet Department Head	Date	Calumet School Dean	Date	Calumet Director of Graduate Studies	Date
Fort Wayne Department Head	Date	Fort Wayne School Dean	Date	Fort Wayne Director of Graduate Studies	Date
Indianapolis Department Head	Date	Indianapolis School Dean	Date	IUPUI Associate Dean for Graduate Education	Date
North Central Department Head	Date	North Central School Dean	Date	North Central Director of Graduate Studies	Date
West Lafayette Department Head	4/6/2016 Date	West Lafayette College/School Dean	Date	Date Approved by Graduate Council	Date
Graduate Area Committee Convener	Date	Graduate Dean	Date	Graduate Council Secretary	Date
				West Lafayette Registrar	Date

OFFICE OF THE REGISTRAR

(Grad Form 40G [Excel format] - Does not include the Graduate Council's required supporting document. See pdf version of Form 40G)

Office of the Registrar
FORM 40G REV. 4/13

PURDUE UNIVERSITY
REQUEST FOR ADDITION, EXPIRATION, OR REVISION OF A GRADUATE COURSE
(50000-60000 LEVEL)

PRINT

DEPARTMENT: Industrial Engineering EFFECTIVE SESSION: Fall 2016

INSTRUCTIONS: Please check the items below which describe the purpose of this request.

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- [ ] 11. Change in semesters offered
- [ ] 12. Transfer from one department to another

PROPOSED:		EXISTING:	
Subject Abbreviation	IE	Subject Abbreviation	IE
Course Number	52000	Course Number	59000
Long Title	Perspectives on Systems Engineering		
Short Title	Perspectives Systems Engr		

Abbreviated title will be entered by the Office of the Registrar if omitted. (30 CHARACTERS ONLY)

TERMS OFFERED (Check All That Apply:)
[x] Fall [ ] Spring [ ] Summer

CAMPUS(ES) INVOLVED
- [ ] Calumet
- [x] Cont Ed
- [ ] Ft. Wayne
- [ ] Indianapolis
- [ ] N. Central
- [ ] Tech Statewide
- [x] W. Lafayette

CREDIT TYPE
1. Fixed Credit: Cr. Hrs. 3
2. Variable Credit Range: Minimum Cr. Hrs ____ (Check One) To [ ] Or [ ] Maximum Cr. Hrs ____
3. Equivalent Credit: Yes [ ] No [ ]
4. Thesis Credit: Yes [ ] No [x]

COURSE ATTRIBUTES: Check All That Apply
1. Pass/Not Pass Only [ ]
2. Satisfactory/Unsatisfactory Only [ ]
3. Repeatable [ ] Maximum Repeatable Credit: [ ]
4. Credit by Examination [ ]
5. Fees [ ] Coop [ ] Lab [ ] Rate Request [ ] Include comment to explain fee
6. Registration Approval Type — Department [x] Instructor [x]
7. Variable Title [ ]
8. Honors [ ]
9. Full Time Privilege [ ]
10. Off Campus Experience [ ]

Schedule Type	Minutes Per Mtg	Meetings Per Week	Weeks Offered	% of Credit Allocated
Lecture	75	2	16	100
Recitation				
Presentation				
Laboratory				
Lab Prep				
Studio				
Distance				
Clinic				
Experiential				
Research				
Ind. Study				
Pract/Observ				

Cross-Listed Courses
AAE 58000

COURSE DESCRIPTION (INCLUDE REQUISITES/RESTRICTIONS):
See supporting documents

***COURSE LEARNING OUTCOMES:**
See supporting documents

Calumet Department Head	Date	Calumet School Dean	Date	Calumet Director of Graduate Studies	Date
Fort Wayne Department Head	Date	Fort Wayne School Dean	Date	Fort Wayne Director of Graduate Studies	Date
Indianapolis Department Head	Date	Indianapolis School Dean	Date	IUPUI Associate Dean for Graduate Education	Date
North Central Department Head	Date	North Central School Dean	Date	North Central Director of Graduate Studies	Date
West Lafayette Department Head	3/8/16 Date	West Lafayette College/School Dean	3/21/16 Date	Date Approved by Graduate Council	Date
Graduate Area Committee Convener	Date	Graduate Dean	Date	Graduate Council Secretary	Date
				West Lafayette Registrar	Date

OFFICE OF THE REGISTRAR

(Grad Form 40G [Excel format] - Does not include the Graduate Council's required supporting document. See pdf version of Form 40G)

(Supporting Materials from Form 40-G)

A. Justification for the Course:

- Justification of Need

Engineers are frequently asked to solve problems of how to get entities (which may or may not naturally organize themselves in favorable configurations) to operate together in an effective way to achieve a goal. The term "systems engineering" (SE) is often used to refer to several different concepts, disciplines, and technical skills; engineering is both a set of rules and practices for what we do, and the processes of solving problems. However, confusion arises when proponents of one perspective interact with others, without a clear understanding of the variety of SE histories and tools. Each can play an important, complementary role in the development of a robust approach to SE and the role of the human in engineering systems.

- Justification of Level

A number of major corporations (for example, General Electric) and government agencies (for example, NASA) are developing "SE" programs for executive trainees and senior technical leaders; nearly all of those programs expect that the SE expertise is built on top of a fundamental engineering emphasis within a more traditional engineering discipline. Thus, it is expected that the overwhelming majority of students in the class will be at the graduate level. This expectation is played out in the two experimental offerings of Perspectives on Systems Engineering (PoSE), in Fall 2014 and 2015. The Fall 2014 offering was delivered both as an on-campus (with IE and AAE registration options) and distance (with an EPE registration option) course. A total of 60 students enrolled and completed the course: 37 EPE, 15 IE, 8 AAE. A total of 16 students enrolled and completed an on-campus only version of PoSE in Fall 2015: 7 IE, 9 AAE. In each offering, the number of undergraduate students in PoSE was under five. Undergraduates were integrated into the project teams with graduate students, and had exactly the same expectations and requirements for all individual assignments.

- Anticipated enrollment
  - Undergraduate 5-10
  - Graduate 30-100

B. Learning Outcomes and Method of Evaluation or Assessment:

ABET Accreditation criteria for Industrial Engineering programs include the following Learning Outcomes relevant to PoSE:

1. an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability
2. an ability to function on multidisciplinary teams
3. an ability to identify, formulate, and solve engineering problems
4. an understanding of professional and ethical responsibility
5. an ability to communicate effectively
6. the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context
7. a recognition of the need for, and an ability to engage in life-long learning
8. a knowledge of contemporary issues
9. prepare graduates to design, develop, implement, and improve integrated systems that include people, materials, information, equipment and energy.

- PoSE Course Objectives and Methods of Evaluation, with maps to Learning Outcomes (in parentheses)

This course will provide students with an introduction to various quantitative and qualitative approaches to systems engineering, with case studies, concepts, and readings to support interdisciplinary project work.

  - Individual Analysis and Participation
    - Three "Quick Response" analyses of Case Studies (3, 4, 5, 6, 9)
    - Individual Paper based on instructor-selected SE topic (3, 4, 5, 6, 7, 8, 9)
    - Individual participation to live discussion and course discussion list, and individually contributed material (3, 5, 7, 8)
  - Collaborative Work
    - Reading and response to course discussion list (2, 5, 7, 8)
    - Two individual responses based on collaborative topic definition (2, 5, 7, 8)
  - Interdisciplinary Project Work
    - Team Based Semester Project:
      - Project Summary and Overview (2, 3, 5, 6, 8, 9)
      - Final Project Report: Process and Product documents (1, 2, 3, 4, 5, 6, 7, 8, 9)

- Methods of Evaluation

Describe the methods of evaluation or assessment of student learning outcomes. (Include evidence for both direct and indirect methods.) Expand table rows as needed.

Learning Objective	Methods of Evaluation
Individual Analysis	Instructor grading of assignment
Collaborative Work	Team topic definition, instructor grading
Interdisciplinary Project Work	Instructor grading of assignment

- Grading Criteria

Grading criteria (select from checklist); include a statement describing the criteria that will be used to assess students and how the final grade will be determined. Add and delete rows as needed.

Grading Criteria (replace with check for all that apply)	Weight Toward Final Grade
Exams and Quizzes	N/A
Papers and Projects	Individual Papers (15%) Collaborative Papers (20%) Team Project (35%)
Homework	15%
Laboratory Exercises	N/A
Attendance and Class Participation	15%
Extra Credit	N/A

- Methods of Instruction

Identify the method(s) of instruction and describe how the methods promote the likely success of the desired student learning outcomes. Add and delete rows as needed.

Hours per Week	Method of Instruction (replace with check for all that apply)	Contribution to Outcomes
3	Lecture	9 of 16 weeks
3	Independent Team	3 of 16 weeks

	Work	
3	Seminar	Case Studies 4 of 16 weeks

C. Prerequisite(s):

List prerequisites and/or experiences/background required. If no prerequisites are indicated, provide an explanation for their absence. Add bullets as needed.

- Graduate Standing or Permission of Instructor

D. Course Instructor(s):

Provide the name, rank, and department/program affiliation of the instructor(s). Is the instructor currently a member of the Graduate Faculty? (If the answer is no, indicate when it is expected that a request will be submitted.) Add rows as needed.

Name	Rank	Dept.	Graduate Faculty or expected date
Barrett S Caldwell	Professor	IE / AAE	Yes
Staff	Professor	IE / AAE	Yes

E. Course Outline:

Provide an outline of topics to be covered and indicate the relative amount of time or emphasis devoted to each topic. If laboratory of field experiences are used to supplement a lecture course, explain the value of the experience(s) to enhance the quality of the course and student learning. For special topics courses, include a sample outline of a course that would be offered under the proposed course. **(This information must be listed and may be copied from syllabus).**

I. [click here and insert outline]

F. Reading List (including course text):

A primary reading list or bibliography should be limited to material the students will be required to read in order to successfully complete the course. It should not be a

compilation of general reference material.

A secondary reading list or bibliography should include material students may use as background information.

- Primary Reading List

- Meadows, D. H. (2008 / 2012). *Thinking in Systems: A Primer*. New York: Chelsea Green Publishing.
- NASA (2007). *NASA Systems Engineering Handbook.* Washington, DC: NASA SP 2007-6105.

- Secondary Reading List

- Handouts, lecture notes, and readings posted through Blackboard system (see syllabus)

G. Library Resources

Describe any library resources that are currently available or the resources needed to support this proposed course.

- Meadows, NASA, and most readings available electronically through library holdings or subscription access

H. Course Syllabus

Example Syllabus from Fall 2015:

Week	Topics	Readings (as of August 15)
1 (Aug 25, 27)	Introduction & Ground Rules | "Flavors" concept;Participation: What's Your Systems?	Caldwell ISERC paper; Meadows, One through Four; NASA, Ch 1, 2
2 (Sep 1, 3)	Systems Thinking | Feedback Control; Participation: Course as System	Hall, 1962; Emery & Trist, 1966
3 (Sep 8, 10)	Stability & Homeostasis | Cybernetics and Setpoints	Meadows, Seven; vonBertalanffy, 1968
4 (Sep 15, 17)	Component-Whole Relations | Parts & Processes; Participation: Components and Connections	Fosshage, 2014; Miller & Miller, 1990; NASA, Ch. 3
5 (Sep 22, 24)	Project Integration and Management | Goals and Purposes	NASA, Ch. 4: Gilbreth, TBD

6 (Sep 29, Oct 1)	Participation: What is the Engineer's Role? | ***Assignment #1 Work*** *(no class)*	Trist, 1981
7 (Oct 6, 8)	Humans and Systems (In, As, With…) | Supervisory Control and Function Allocation; Participation: Where are the Humans?	Committee, 2007; Sheridan, 2006; Tulga & Sheridan, 1980
8 (Oct 13, 15)	**October Break** *(no class)* | Project and Cases Intro	Meadows, Five and Six
9 (Oct 20, 22)	Beer Game, Case #1: Vasa | (Case #1 Response) *(no class)*	Sterman; NASA ESMD
10 (Oct 27, 29)	***Assignment #2 Work*** *(no class)*	
11 (Nov 3, 5)	Case 2: Mission Operations | Distributed Supervisory Coordination	Caldwell, 2005; Garrett et al., 2008
12 (Nov 10,12)	Cases 3, 4: Polar Vortex; E. L. Cord | Framing and Decisions	Caldwell, 2014; Kahneman, 2003
13 (Nov 17, 19)	Cyber-Physical Hybrids | Event Response	Garrett; Copeland
14 (Nov 24, 26)	***Individual Papers Due*** | **Thanksgiving**	
15 (Dec 2, 4)	*Project Activity (discussion, no lecture)*	
16 (Dec 9, 11)	Final Topics | Q&A	TBD
17	***FINAL PAPERS DUE DEC 16 12:00 N***	