LSC Use Only **Proposal No:** **LSC Action-Date:**	*UWUCC Use Only* **Proposal No:** 11-53h **UWUCC Action-Date:** AP-12/13/11 **Senate Action Date:** App-01/24/12

Curriculum Proposal Cover Sheet - University-Wide Undergraduate Curriculum Committee

Contact Person(s) **Mr. Pat Yorio**	Email Address **P.L.Yorio@iup.edu**
Proposing Department/Unit **Safety Sciences**	Phone **7-3270**

Check all appropriate lines and complete all information. Use a separate cover sheet for each course proposal and/or program proposal.

1. Course Proposals (check all that apply)

_____ New Course _____ Course Prefix Change _____ Course Deletion

__X__ Course Revision __X__ Course Number and/or Title Change __X__ Catalog Description Change

Current course prefix, number and full title : ***SAFE 345 Systems Safety Analysis***

Proposed course prefix, number and full title, if changing: ***SAFE 345 Process and System Safety***

2. Liberal Studies Course Designations, as appropriate

_____ This course is also proposed as a Liberal Studies Course (please mark the appropriate categories below)

_____ Learning Skills _____ Knowledge Area _____ Global and Multicultural Awareness _____ Writing Intensive (include W cover sheet)

_____ Liberal Studies Elective (please mark the designation(s) that applies – must meet at least one)

_____ Global Citizenship _____ Information Literacy _____ Oral Communication

_____ Quantitative Reasoning _____ Scientific Literacy

3. Other Designations, as appropriate

_____ Honors College Course _____ Other: (e.g. Women's Studies, Pan African)

4. Program Proposals

_____ Catalog Description Change _____ Program Revision _____ Program Title Change _____ New Track

_____ New Degree Program _____ New Minor Program _____ Liberal Studies Requirement Changes _____ Other

Current program name: _____

Proposed program name, if changing: _____

5. Approvals	**Signature**	**Date**
Department Curriculum Committee Chair(s)	**Dr. Jan K. Wachter** Jan K Wachter	9-13-2011
Department Chairperson(s)	**Dr. Lon Ferguson** Lon D. Ferguson	9-15-2011
College Curriculum Committee Chair	**Dr. Jan K. Wachter** Jan K Wachter	10-20-2011
College Dean	**Dr. Mary Swinker** Mary E Swinker	10/21/11
Director of Liberal Studies (as needed)		
Director of Honors College (as needed)		
Provost (as needed)		
Additional signatures (with title) as appropriate:		
UWUCC Co-Chairs	Gail S Sechrist	12/13/11

Received
OCT 24 2011
Liberal Studies

Course Revision: SAFE 345 Systems Safety

Part II. Description of the Curriculum Change

1. Syllabus of Record.

   The revised syllabus of record is attached in Appendix A.

2. A summary of the proposed revisions:

   a. The course name, prerequisites, description, objectives and content were updated to better reflect program outcomes and to address changes in field of process and systems safety. Changes in course description are shown in **bold** below.

   New Course Description

   SAFE 345 **Process and** Systems Safety (3c-01-3cr)
   Prerequisites: MATH 105 **and SAFE 111** or instructor permission

   Focuses on the evaluation of system designs using detailed system analysis techniques. Topics covered include system definition, economics of systems safety, **quantitative and qualitative systems safety methodology**, and systems safety / **process safety program administration**. Skills gained include the ability to perform **hardware and human factors systems analysis**. Techniques include failure mode and effect analysis, hazard and operability studies, **what-if and scenario building,** and operating and support hazard analysis. Practical analysis work is accomplished through in-class discussion and **demonstration sessions** and homework assignments.

   Old Course Description

   SAFE 345 Systems Safety Analysis (3c-01-3cr)
   Prerequisites: MATH 105 or instructor permission

   Focuses on the evaluation of system designs using detailed system analysis techniques. Topics include system definition, economics of systems safety, systems safety methodology, mathematics of systems analysis including statistical methods, Boolean algebra, and reliability. Skills gained include the ability to perform system hazard analyses and operating and support hazard analyses. Techniques include failure mode and effect analysis, fault tree analysis and technique for human error rate prediction. Practical analysis work is accomplished through in-class discussion and demonstration sessions and homework assignments.

3. Justification/rationale for the revision.

   The field of systems safety has evolved rapidly over the last decade. The federal government has recently published national emphasis programs of federal legislation which requires very specific systems safety programs (29 CFR 1910.119). For example, Directive 03-00-010 (August 18, 2009) puts forth a Petroleum Refinery Process Safety Management National Emphasis Program and CPL 02-02-045 which defines the compliance guidelines and enforcement procedures for OSHA's process safety management regulation. Further, a consensus standard has materialized and has occupied a solid position as a leading

1910.119 compliance document (ANSI / ISA – 284.00.01-2004 Parts 1-3). The process safety management program represents a current and comprehensive approach to systems safety management which can be used as a universal guideline for all systems safety programs. Thus, incorporating more of an emphasis on the process safety management guidelines will prepare student for the current trends in systems safety management industry wide. Further, while the emphasis on specific management techniques for systems safety (per OSHA guidelines) has increased other methodologies have become dated and considered by some to be obsolete. One example of this is Fault Tree Analysis (FTA). Thus, the content of the course was changed to emphasize process safety and to de-emphasize methods such as FTA.

Because of these regulations-based changes to the field of systems safety, an additional course was added as a prerequisite for SAFE 345, SAFE 111 Principles of Safety I – General Industry, which is an OSHA regulations-based course.

4. The old syllabus of record.

   The old syllabus of record is attached in Appendix B.

5. Liberal Studies course approval.

   Not applicable.

Part III. Letters of Support or Acknowledgement

This course is not a required or recommended course in another program so letters of support from other departments were not requested.

Appendix A: New Syllabus of Record

I. Catalog Description

SAFE 345 Process and Systems Safety	3 class hours 0 lab hours
Prerequisites: MATH 105 and SAFE 111 or instructor permission	3 credit hours (3c-01-3cr)

Focuses on the evaluation of system designs using detailed system analysis techniques. Topics covered include system definition, economics of systems safety, quantitative and qualitative systems safety methodology, and systems safety / process safety program administration. Skills gained include the ability to perform hardware and human factors systems analysis. Techniques include failure mode and effect analysis, hazard and operability studies, what-if and scenario building, and operating and support hazard analysis. Practical analysis work is accomplished through in-class discussion and demonstration sessions and homework assignments.

II. Course Objectives

Students will be able to:

A. Develop and manage a systems safety program in accordance with process safety regulations.

B. Explain the general concept of a system, system design processes and the system life cycle.

C. Construct organizational policies for preparing system safety program plans and for conducting system safety analyses.

D. Perform various hazard identification methods used in systems safety analysis.

E. Develop the parameters for and perform a risk assessment on identified hazards and an overall criticality analysis.

F. Recommend controls for systems hazards identified according to the precedence of controls.

G. Apply appropriate system safety analysis methods.

H. Use system safety applications to control an organization's exposure to accidents and losses due to product liability.

III. Course Outline

A. Systems Safety Analysis Overview (2.5 hours)
   1. Discussion of why knowledge of and skills in systems safety are increasingly critical for the safety professional:
      a. Increasing sophistication of manufacturing technology and technological processes
      b. OSHA's process safety management standard
   2. Historical Development of Systems Safety
   3. Military Standard-882D System Safety Program Requirements
   4. Contexts where systems safety is required

B. Overview of Systems Safety Programs (Per Process Safety Guidelines) (4.5 hours)
   1. Employee Participation
   2. Systems / Process Safety Information
   3. Hazard Analysis
   4. Operating Procedures
   5. Employee Training
   6. Mechanical Integrity
   7. Contractors
   8. Pre-Start-up Safety Review
   9. Management of Change
   10. Incident Investigation Overview

C. Accident Causation Models (2.5 hours)
   1. Clarification of Terminology
   2. Historical Models
   3. Contemporary Models

D. Overview of Systems Concepts (2.5 hours)
   1. Definitions
   2. Systems
   3. Subsystems
   4. Components
   5. System Safety Lifecycle

E. Hazard Identification Methods for Systems Safety (3.5 hours)
   1. The Process of Hazard Identification
   2. What if
   3. Cause Consequence
   4. Functional Block Analysis
   5. Checklists
   6. Analytical Trees

F. Examination #1 (1 hour)

G. System Safety Risk Assessment (3.5 hours)
   1. Definition of Risk Types
   2. Quantifying Risk
   3. Developing Risk Assessment Codes
   4. Risk Assessment Charts
   5. Criticality Analysis

H. Systems Safety Risk Control (2.5 hours)
   1. Laws of Acceptable Risk
   2. Human Factors vs. Hardware Factors
   3. Precedence of Hazard Control

I. Overview of Systems Analysis Techniques and Assumptions (4.5 hours)
   1. Human Factors
   2. Hardware Factors
   3. Quantitative Techniques
   4. Qualitative Techniques
   5. Preliminary Hazard Lists & Analysis
   6. System and Subsystem Hazard Analysis

J. Human Factors Theory (3 hours)
   1. Human Factors Theory Overview
   2. Human Error and Human Error Types
   3. Management Systems which influence Human Error
   4. Quantifying Human Reliability
   5. Qualitative Techniques For Human Reliability

Examination #2 (1 hour)

K. Specific Hazard Analysis Techniques (5.5 hours)
   1. Failure Modes and Effects Analysis
   2. Hazard and Operability Studies
   3. Operating and Support Hazard Analysis
   4. What-if
   5. Energy Trace Barrier Analysis

L. Systems Incident Investigation (3.5 hours)
   1. The role of systems incident investigation and root cause analysis
   2. The definition of Root Cause Analysis
   3. Hardware Root causes
   4. Personnel Root causes

M. Product Liability (2 hours)
   1. Developing a Product Liability Loss Control Program
   2. Using Systems Safety to Reduce Product Liability

Final Exam (2 hours in final exam week)

IV. Evaluation Methods

The faculty person assigned to teach this course could be one of several faculty members within the Department of Safety Sciences. Following is an example of the evaluation methods and weighting used by one of those faculty members.

~40% Exams	There will be three (3) written exams consisting of combinations of multiple choice, true/false and matching questions.
~60% Assignments	Periodic in-class assignments and out-of-class assignments will be given. These will consist of problems, systems analysis, etc. to be solved by the student.

V. Example Grading Scale

The grading scale will be based on the following:

A = 90-100%
B = 80-89%
C = 70-79%
D = 60-69%
F < 60%

A grading curve that results in an appropriate distribution of grades may be used as needed.

VI. Course Attendance Policy

The undergraduate course attendance policy will be consistent with the university undergraduate attendance policy included in the Undergraduate Catalog.

VII. Textbook

Stephans, R. A. (2004). *System Safety for the 21st Century.* New York: John A. Wiley and Sons, Inc. ISBN 0-471-44454-5

VIII. Special Resource Requirements

None

IX. Bibliography

Center for Chemical Process Safety (2008). *Guidelines for Management of Change for Process Safety.* New York, NY: Wiley—AIChE.

Davies, J. B., et al. (2003). *Safety Management: A Qualitative System Approach.* London, England: Taylor and Francis Publishing Company.

Stephans, R. A. (2004). *System Safety for the 21st Century.* New York, NY: John A. Wiley and Sons, Inc.

Yang, G. (2007). *Life Cycle Reliability Engineering.* Hoboken, NJ: John Wiley & Sons, Inc.

Historical Titles

Apostalakis, G.E., et al. (1988). *Accident Sequence Modeling.* London, England: Elsevier Applied Sciences.

Center for Chemical Process Safety (1994). *Guidelines for Implementing Process Safety Management Systems.* New York: Wiley –AIChE.

Department of Defense. (1993). *Military Standard 882D: System Safety Requirements.* Washington, D.C.: United States Department of Defense.

Hammer, W. (1972). *Handbook for System and Product Safety.* Englewood Cliffs, CA: Prentice Hall.

Henley, G. & Kumamoto, H. (1980). *Reliability Engineering and Risk Assessment.* Englewood Cliffs, CA: Prentice Hall.

Layton, D. M. (1989). *System Safety Including DOD Standards.* Chesterland: Weber Systems Inc.

Levenson, N. G. (1995). *Safeware.* New York, NY: Addition-Wesley Publishing Co.

O'Conner, P. D.T. (1985). *Practical Reliability Engineering, 2nd Edition.* Chichester, UK: John Wiley and Sons.

Roland, H. E. (1990). *System Safety Engineering and Management.* New York, NY: Wiley Interscience.

Stephenson, J. (1991). *System Safety 2000.* New York, NY: Van Nostrand Reinhold.

Swain, A.D. (1975). *The Human Element in System Safety – A Guide for Modern Management.* London, England: In Com Tec.

System Safety Society (1997). *System Safety Analysis Handbook.* Albuquerque, NM: System Safety Society.

Vincoli, J. W. (1993). *Basic Guide to System Safety.* New York, NY: Van Nostrand Reinhold.

Appendix B: Old Syllabus of Record

I. Catalog Description

SAFE 345 Systems Safety Analysis	3 class hours 0 lab hours
Prerequisites: MATH 105 or Instructor Permission	3 credit hours (3c-0l-3cr)

Focuses on the evaluation of system designs using detailed system analysis techniques. Topics include system definition, economics of systems safety, systems safety methodology, mathematics of systems analysis including statistical methods, Boolean algebra, and reliability. Skills gained include the ability to perform system hazard analyses and operating and support hazard analyses. Techniques include failure mode and effect analysis, fault tree analysis and technique for human error rate prediction. Practical analysis work is accomplished through in-class discussion and demonstration sessions and homework assignments.

II. Course Outcomes

Students will be able to:

A. Explain the general concept of a system, system design processes and the system life cycle.

B. Construct organizational policies for preparing system safety program plans and for conducting system safety analyses.

C. Develop a system safety program plan that can be used to evaluate a system using a variety of system safety techniques.

D. Demonstrate they can perform various system safety analyses methods.

E. Utilize appropriate system safety techniques on any technological system to complete a risk assessment.

F. Diagram Event Trees and Cause Consequence Charts and explain how these can be used to provide useful information about system risk.

G. Recognize the role of the Software Systems and be able to identify analysis techniques that can be applied to these unique systems.

H. Demonstrate an understanding of reliability concepts and be able to solve mathematical reliability problems relevant to system safety.

I. Demonstrate an understanding of how to use system safety applications to control an organization's exposure to accidents and losses due to product liability.

III. Course Outline

A. Overview of Systems Concepts (2.5 hours)
   1. Definitions
   2. Systems
   3. Subsystems
   4. Components
   5. System Safety Lifecycle

B. Military Standard-882D System Safety Program Requirements (2.5 hours)
   1. Background
   2. Task Descriptions
   3. Evaluation Criteria

C. Systems Safety Program Planning (3.5 hours)
   1. Program Organization
   2. System Safety Program Plans
   3. Management Planning
   4. Milestone Charts
   5. System Safety Workgroups

D. Overview of Analysis Techniques (5.5 hours)
   1. Quantitative Techniques
   2. Qualitative Techniques
   3. Preliminary Hazard Lists
   4. Preliminary Hazard Analysis
   5. Event Diagrams
   6. System and Subsystem Hazard Analysis
   7. Operator and Support Hazard Analysis
   8. Health Hazard Analysis

Examination #1 (1 hour)

E. Statistical Techniques (2.5 hours)
   1. Component Reliability
   2. System Reliability
   3. Probability of Failure
   4. Systems in Series
   5. Systems in Parallel

F. Risk (2.5 hours)
   1. Definition of Risk
   2. Quantifying Risk
   3. Developing Risk Assessment Codes
   4. Risk Assessment Charts

G. Boolean Algebra (2 hours)
   1. Boolean Postulates
   2. Developing Boolean Equations

H. Fault Tree Analysis (FTA) (5.5 hours)
   1. Fault Trees Versus Reliability Trees
   2. Establishing Fault Trees
   3. Forming Boolean Equations from Fault Trees
   4. Analyzing Systems using FTA

Examination #2 (1 hour)

I. Failure Modes and Effects Analysis (FMEA) (3 hours)
   1. Assumptions of FMEA
   2. Analyzing Systems Using FMEA

J. Hazard Analysis Techniques (4.5 hours)
   1. HAZOP
   2. Cause-Consequence
   3. Flow Analysis
   4. What if
   5. Energy Trace Barrier Analysis

K. Operator and Support Hazard Analyses (4 hours)
   1. Procedure (Task) Analysis
   2. Human Reliability Analysis
   3. Technique for Human Error Rate Prediction
   4. Critical Incident Technique
   5. Link Analysis
   6. Management Oversight Risk Tree
   7. Technique for Operational Review

L. Product Liability (2 hours)
   1. Developing a Product Liability Loss Control Program
   2. Using Systems Safety to Reduce Product Liability

Final Exam – during final exam week

IV. Evaluation Methods

The faculty person assigned to teach this course could be one of several faculty members within the Department of Safety Sciences. Following is an example of the evaluation methods and weighting used by one of those faculty members.

~40% Exams	There will be three (3) exams consisting of combinations of multiple choice, true/false and matching questions.
~60% Assignments	Periodic in-class assignments and out-of-class assignments will be given. These will consist of problems, systems analyses, etc. to be solved by the student.

V. Example Grading Scale

The grading scale will be based on the following:

A = 90-100%
B = 80-89%
C = 70-79%
D = 60-69%
F < 60%

A grading curve that results in an appropriate distribution of grades may be used as needed.

VI. Course Attendance Policy

Although there is no formal attendance policy for this class, student learning is enhanced by regular attendance and participation in class discussions and the university expects all students to attend class.

VII. Required Textbooks

Stephans, Richard A. (2004). System Safety for the 21st Century. New York: John A. Wiley and Sons, Inc. ISBN 0-471-44454-5

VIII. Special Resource Requirements

None

IX. Bibliography

Davies, John Booth, et al. (2003). Safety Management: A Qualitative System Approach. London, England: Taylor and Francis Publishing Company.

Yang, Guangbin (2007). Life Cycle Reliability Engineering. Hoboken, NJ: John Wiley & Sons, Inc.

Historic Titles

Apostalakis, G.E., et al. (1988). Accident Sequence Modeling. London: Elsevier Applied Sciences.

Barlow, R.E., et al. (1975). Reliability and Fault Tree Analysis. Philadelphia, PA: Society for Industrial and Applied Mathematics.

Browning, R.L. (1980). The Loss Rate Concept in Safety Engineering. New York, NY: Marcel-Deskker Inc.

Copi, Irving M. (1986). Introduction to Logic, 7th Edition. New York, NY: MacMillan Publishing.

Department of Defense. (1993). Military Standard 882D: System Safety Requirements. Washington, D.C.: United States Department of Defense.

Engineering Design Handbook – Fault Tree Analysis. (1971). Washington, DC: US Army Material Command.

Green, A.E. (1984). Safety Systems Reliability: Chichester, UK: John Wiley and Sons.

Hammer, Willie. (1972). Handbook for System and Product Safety. Englewood Cliffs, CA: Prentice Hall.

Henley, G. and Kumamoto. (1980). Reliability Engineering and Risk Assessment. Englewood Cliffs, CA: Prentice Hall.

Iredon, W. Grant, ed.. (1966). Reliability Handbook. New York, NY: McGraw Hill Book Co..

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Levenson, Nancy G. (1995). Safeware. New York, NY: Addition-Wesley Publishing Co.

Malasky, Sol W. (1984). System Safety Planning/Engineering/Management, 2nd Edition. Princeton, NJ: Hayden Book Co.

O'Conner, Patrick D.T. (1985). Practical Reliability Engineering, 2nd Edition. Chichester, UK: John Wiley and Sons.

Roland, Harold E. (1990). System Safety Engineering and Management. New York, NY: Wiley Interscience.

Stephenson, Joe. (1991). System Safety 2000. New York, NY: Van Nostrand Reinhold.

Swain, A.D. (1975). The Human Element in System Safety – A Guide for Modern Management. London: In Com Tec.

System Safety Society. (1997). System Safety Analysis Handbook. Albuquerque, NM: System Safety Society.

Thompson, J.R. (1987). Engineering Safety Assessment: An Introduction. Essex, UK: Longman Scientific and Technical Publishers.

Vesely, W.E., et al. (1981). Fault Tree Handbook. NUREG-0492. Washington, DC: Nuclear Regulatory Commission.

Vincoli, Jeffrey W. (1993). Basic Guide to System Safety. New York, NY: Van Nostrand Reinhold.

Appendix C: Proposed Revised Catalog Description

SAFE 345 Process and Systems Safety **3c-01-3cr**
Prerequisites: MATH 105 and SAFE 111 or instructor permission

Focuses on the evaluation of system designs using detailed system analysis techniques. Topics covered include system definition, economics of systems safety, quantitative and qualitative systems safety methodology, and systems safety / process safety program administration. Skills gained include the ability to perform hardware and human factors systems analysis. Techniques include failure mode and effect analysis, hazard and operability studies, what-if and scenario building, and operating and support hazard analysis. Practical analysis work is accomplished through in-class discussion and demonstration sessions and homework assignments.