SYSTEMS ENGINEERING (SYEG)

SYEG 500 Systems Engineering (3 semester hours)
Fundamentals of modern Systems Engineering (SE) throughout the program lifecycle; focus on mission success, system, and system-of-systems; broad integrative adoptable and flexible thinking; initiation of a SE activity, feasibility studies, mission engineering, pre-proposal and proposal activities; risk in performance, cost, schedule and deployment aspects of a project; requirement definition and development, system design, interface and configuration control, and verification/validation; introduction to critical aspects of the DoD, NASA, and INCOSE guides on SE; class projects in Integrated Product Development Teams. All students have an option to receive 20% of the grade for taking the INCOSE Associate Systems Engineering Professional (ASEP) Certification Examination.

SYEG 510 Project Management (3 semester hours)
This course will integrate project management theory with practical approaches to establish a fundamental knowledge base for use in today's contemporary dynamic business environment. Project management will be explored from planning and selection through all aspects of the project life cycle. Practical techniques will be developed to organize and control non-routine activities in order to properly manage schedule, quality, budget, and performance objectives. The course will concentrate on project management areas identified as core knowledge areas by the Project Management Institute (PMI). The areas include the management of: Project Integration, Scope containment, Time, Cost, Quality, Human Resources, Procurement, and Risk.

SYEG 520 Engineering Leadership and Integrity (3 semester hours)
The Engineering Ethics and Communications course covers the study of the moral issues and decisions confronting individuals and the organizations involved in engineering, and the study of related questions about moral conduct, character, ideals, and the relationships of people and organizations involved in technological development. The aim of the course is to learn and apply integrity-based decision making skills to work related situations, in order to make decisions based on principles and values rather than motivated by profit, greed, convenience, laziness or time pressures. This course is an application of ethical theory to moral problems confronted by engineers, scientists, and managers, e.g., conscience and free expression within corporations, professional obligations to the public, the role of values in decisions regarding safety, codes of ethics, whistle-blowing, etc. This course includes a Communications element where students learn and demonstrate some of the basics of professional report writing and public speaking, including: analyzing the ethical environment in which students work, identify the student's company's ideology and ethical outlook; examine the practical ethical problems in the student's organization and professional position; develop awareness of the ethical impact of decision making; discern the personal self-discipline of an ethical engineer and engineering manager; demonstrate a graduate level of proficiency in writing and public speaking through written assignments and formal class PowerPoint presentations.

SYEG 530 Lean Engineering and Management (3 semester hours)
This course covers the basics of Lean Engineering and manufacturing, including the history of Lean, Lean fundamentals: principles, value and waste. Lean Manufacturing with detailed coverage of JIT/LEAN Tools; Kaizen, Gemba, Hoshin Kanry. Lean engineering is applied in a variety of domains: Office, Supply Chain, Accounting, Labor relations. The NUMMI Case Study will be analyzed showing the value of applying lean principles; Time permitting the Theory of Constraints and Critical Chain will be reviewed. A key element of the course is a class project that implements the elements of the course.

SYEG 540 Systems Thinking: Major Tech Changes/Impacts (3 semester hours)
Systems Thinking is a course in which both students and faculty of two LMU Colleges work together: Bellarmine College of Liberal Arts (Seniors and Honors) and Frank R. Seaver College of Science and Engineering (the Systems Engineering graduate program). We look at complex systems that combine both technological and societal aspects of our civilization, seeking to understand how things influence one another within a large context, and how we can influence them for common good. The concepts of common good and public interest are discussed and serve as the ethical baseline for the discourse on the big questions of our time, such as: healthcare, energy and transportation, public health, K-12 education, end-of-life health management, defense and homeland security, and others. Systems engineering and liberal arts students will complement each other's thinking. Non-HSE students only.

SYEG 554 Engineering for Autonomy (3 semester hours)
This course will provide an understanding of what architecture is, why we need it and common architectural patterns used in software-intensive systems. It examines architecture from different viewpoints to develop understanding of the factors that matter in practice, not just in theory. The issue of evolving software intensive eco-systems will be explored, including: design of domain appropriate architectures and what it means to be an evolvable architecture, how architecture fits into the specification of software intensive systems, techniques to visualize software-intensive architectures, and common software architectural patterns and the problems they are designed to address. Key trades for systems implementation will also be discussed, such as: service, object and data oriented design principles, embedded and enterprise architectural solutions, centralized and distributed architectures, and cloud computing architectures.

SYEG 557 Agile Development and Project Management (3 semester hours)
Agile software development is a set of principles for software development in which requirements and solutions evolve through collaboration between self-organizing, cross-functional teams. The course addresses agile methodologies and their impact on software engineering from a project manager perspective. A variety of agile methods will be reviewed as well as the pros and cons. Issues associated with planning and controlling agile projects, along with the challenges associated with adopting agile methods are discussed. Note: Some previous coding experience is highly desirable. The team nature of the project means that extensive programming experience is not required.

SYEG 560 Introduction to Cybersecurity (3 semester hours)
Systems engineering approach to cybersecurity in modern, highly networked organizations in either the private or public sector. NIST's formal framework of terms, concepts, and methods to understand the area of cybersecurity. Studies of realistic threat models and vulnerability assessments. Comprehensive coverage of technical foundations for extant technologies and tools available at different levels (host-based or network-based) to provide cybersecurity"anti-virus software, malware detection, intrusion detection/prevention, firewalls, denial of service attack mitigation, encryption, network monitoring, automatic audit tools, to name just a few. Complications in cybersecurity introduced by emerging trends such as mobile devices and cloud computing. As advocated by most security professionals, this course views the problem of devising cybersecurity solutions as a specific kind of risk management problem. Students are taught how to devise the optimal combination of management procedures and controls along with key technologies to address the relevant sets of cybersecurity threats and vulnerabilities for the organization. We will also cover related organizational concerns such as creating a disaster recovery and business continuity plan that can be used to minimize the impact of potential disruptions, including those related to security. The role of cybersecurity as part of the larger domain of Information Assurance and regulatory compliance issues for different types of organizations. "Best practices" frameworks for security such as OWASP Top 10 and Security Technical Implementation GuideS (STIGS) and resources available from institutions such as CERT, NIST, and SANS. Case studies. From the real world to ground the concepts taught in real-world situations. Undergraduate degree in Computer Science required.

SYEG 563 Cyberdefense (3 semester hours)
This course covers what is needed at the tactical level to implement an enterprise approach for the protection of information systems by integrating technical controls with policies, best practices, and overall guidelines of cybersecurity. This course is designed to focus on the practical application of the detection and prevention of cyber attacks and to assess and limit the damage through proactive defensive cyber operations. This course examines external and internal security threats, and the risks to business relative to people, processes, data, facilities, and technologies. How to implement and manage effective the major technical components of security architectures (firewalls, virtual private networks, etc.) and selected methods of attacking enterprise architectures also will be addressed. Additional topics include conducting risk assessments and the implementation of mitigations/countermeasures; intelligence reporting, threat/vulnerability analysis and risk remediation; management of a security operations center; incident response and handling; business continuity planning and disaster recovery; security policy formulation and implementation; management controls related to cybersecurity programs; and privacy. legal, compliance, and ethical issues.

SYEG 570 Spacecraft Design (3 semester hours)
Students will work individually and in groups to create a top-level design for Earth-orbiting satellites to perform a chosen mission. Students will begin by calculating key attributes and parameters for various satellite orbits. After selecting a mission objective, they will perform basic design and sizing calculations for spacecraft subsystems, including communications, power, thermal, propulsion, attitude control, and learn how to design for space environments and achieve desired mission reliability. The course requires basic knowledge of Newton's Laws, linear and rotational equations of motion, impulse/momentum, exponential/logarithmic functions and trigonometric functions.

SYEG 572 Spacecraft Communications and Radar (3 semester hours)
This course presents the fundamentals of satellite communications link design. Existing commercial, civil, and military communications systems are reviewed and analyzed, including direct broadcast satellites, high throughput satellites, VSAT links, and Earth-orbiting and deep space spacecraft. Topics include satellite orbits, link analysis, antenna and payload design, interference and propagation effects, modulation techniques, coding, multiple access, and Earth station design. Modules on optical communications and radar are also included.

SYEG 576 Business Law for Engineers (3 semester hours)
This course introduces engineers to the basic legal principles they will encounter throughout their careers. Course discussions cover contracts (formation, performance, breach, and termination), corporations and partnerships, insurance, product liability, professional liability, intellectual property (patents, trademarks, and copyrights), risk management, environmental law, torts, and evidence and dispute resolution. The course emphasizes those principles necessary to provide engineers with the ability to recognize issues that are likely to arise in the engineering profession and introduces them to the complexities and vagaries of the legal profession.

SYEG 577 Engineering Economics and Finance (3 semester hours)
The course will cover the financial and economic analysis essential for engineering business. Topics include: time value of money relationships, nominal and effective interest rates, present worth method, annual worth method, rate of return and incremental analysis, depreciation and income taxes, replacement analysis and benefit/cost analysis, cost estimating, and consideration of taxes and inflation. The basics of financial analysis and financial statements will be reviewed. Case studies will be used to apply the engineering economics principles.

SYEG 584 Occupy Mars: Explorations in Space Travel and Colonization (3 semester hours)
This multi-disciplinary course examines the potential for near term travel to and settlement of Mars, including the various habitat, technical, medical, mental, and environmental challenges of space travel. The course will start with the history of crewed spaceflight, previous uncrewed missions to Mars and planned future missions. It covers the basic science and technology involved in space programs, as well as the benefits, costs, risks, the political and cultural challenges. We will discuss and develop the requirements for travel to Mars, including the space transportation systems, life support systems, landing systems, habitat requirements on Mars and how to sustain life during transit and once on the red planet. We will assess the current state of technology, including current US, international and private space activities, and develop an understanding of what is required to conduct an initial crewed mission to Mars, as well as what is required to sustain life on Mars for the long term. Junior or senior standing required for undergraduates.

SYEG 586 Launch Vehicle Technology and Design Evolution (3 semester hours)
This course provides an overview of launch vehicles and launch vehicle technology, including a foundation for understanding system analysis and design principles as well as the related systems engineering processes. The course will cover the history and evolution of rocketry including the geopolitical influences that have shaped launch vehicle development and design. Government and commercial applications of future launch vehicle architecture and technology will also be explored.

SYEG 587 Resilient Space Systems Design (3 semester hours)
The concepts presented in this course provide guidance for designing for resilience and the trades that are best considered to accomplish it. Commercial and Civil space systems designers have to consider the impact of hazards to satellites and planetary probes that include solar flares and space weather, the natural radiation environment and other threats. Designers of military satellites have to consider nuclear effects and intentional interference in addition to the natural hazards. As space grows more congested, additional threats are posed by neighboring satellites and the growing problem of space debris. The study of resilience encompasses all of these concerns as well as the mitigation of emerging threats to both satellites and the associated ground systems, such as cyber-attacks.

SYEG 588 Satellite Guidance, Control, and Operations (3 semester hours)
This course provides an introduction to satellite guidance, control, and operations systems engineering. The first part of the course will introduce the major elements of the guidance and control system and describe how they interact with each other. We will also learn how requirements drive unit selection and system design. The latter part of the course will provide an introduction to spacecraft post-launch operations, covering initial orbit raising and spacecraft testing through on-station operations. We will also discuss spacecraft autonomy and contingency operations. Real-life examples will be provided to emphasize key concepts.

SYEG 598 Special Studies (1-3 semester hours)

SYEG 599 Independent Studies (1-3 semester hours)

SYEG 600 Advanced Systems Engineering and Program Management (3 semester hours)
This course will cover the skills required for systems engineers to move into program management, and for program managers to become successful leaders. The course will examine key system engineering processes and their utility for programmatic decision-making (Risk & Opportunity management, Technical Performance Measures, schedule execution metrics, etc.). We will study transition into program management, with a focus on requisite soft skills (e.g., leadership types, team development and motivation, communication) and hard skills (e.g., decision making, risk management, issue management). We will study the customer's view and influence on programmatic decisions and execution. Later lectures will consider program leadership and execution within the context of the broader corporate enterprise and address concepts such as corporate strategy, branding, and product development. Prerequisite: SYEG 500.

SYEG 620 Manufacturing Processes and Quality Systems (3 semester hours)
This course teaches the essential components that effective corporations use to achieve implement robust manufacturing process, and rigorous quality systems to ensure maximum customer satisfaction at the lowest overall cost, by delivering quality products and services. Manufacturing Processes and Quality Systems are taught through a series of lectures and hands-on simulations in the lab/design center and projects that demonstrate the critical elements of both Manufacturing Processes and Quality Systems. The essential elements of developing designs for manufacturability, quality control processes and supplier quality within an organization will be reviewed. This course will promote mastery of the basic concepts and practices of manufacturing processes and quality system management through a review of basic manufacturing and quality concepts such as Product and Process Design, Product and Process Control, Six Sigma, Statistical Process Control and Design of Experiment. This course is applicable to a wide range of businesses and organizations including manufacturing, service, government, education, and healthcare.

SYEG 640 Model Based Systems Engineering (3 semester hours)
This course is a follow on course to Systems Architecture that incorporates the use of Model Based Systems Engineering (MBSE) with an additional focus on the Object Management Group's standard system modeling language (SysML). Topics include the history of and influences on MBSE; the role of Ontologies and Meta Models in MBSE; model usage for requirements analysis, specialty engineering, systems architecting, functional analysis, trade space analysis, performance analysis and costing; MBSE in the context of Model Based Engineering (MBE) across disciplines (Systems, Software, Mechanical, Electrical, etc.); and examples of MBSE including System of Systems, Mission Analysis, Operational/Business analysis, and platform-specific system trades space analysis. The SysML focus area will concentrate on development of SysML and physics-based model examples using modeling tool suites to facilitate understanding of the four pillars of SysML: Structure, Behavior, Requirements, and Parametrics, and translate those models into practical solutions. Students will learn to plan the use of MBSE processes and methods in the Systems Engineering lifecycle; leverage the systems architecture context for systems models and specify the boundary conditions for subsequent analytic and simulation studies; select the appropriate level of granularity for modeling various systems engineering trades; use standards-based tools to create, update, and deploy system models; and conduct engineering trade study analyses based on system Quality Attributes. Prerequisite: SYEG 500.

SYEG 650 Systems Architecture (3 semester hours)
This course will enable students to create, develop, and integrate complex system architectures. Specific goals include 1) improve the student's understanding of the role of system architects and their relationship to systems engineering and integration, 2) applying the system architecture concepts to define an enterprise baseline, 3) creating an architectural blueprint for transforming the enterprise, 4) identifying capability gaps as well as redundancies, and 5) facilitating effective systems integration. Course objectives will be met through lectures, discussions, readings, in-class team exercises, and applied case studies. Prerequisite: SYEG 500 or concurrent enrollment.

SYEG 651 Software Architecture (3 semester hours)
This course will provide an understanding of what software architecture is, why we need it and common architectural patterns used in software-intensive systems. It examines architecture from different viewpoints to develop understanding of the factors that matter in practice, not just in theory. It examines two aspects that are specific to the issue of evolving software intensive eco-systems: design of domain appropriate architectures and what it means to be an evolvable architecture.

SYEG 662 Secure Software Development (3 semester hours)
Theoretical foundations and best practices in software development security. This course will examine the application of security techniques in all phases of the software life cycle (from requirements analysis through deployment and maintenance) with emphasis on writing secure code and application layer security. This course will provide introductions to the various methodologies to increase secure coding awareness and boost code integrity. Topics will cover common malicious attack vectors in application layer vulnerabilities such as SQL injections, Cross Site Scripting (XSS), and those found in the OWASP Top 10 CWE/SANS TOP 25 Most Dangerous Software Errors. The course will cover static and dynamic code analysis and identify tests, environments, tools, and the documentation of findings. As the tools necessary for effectively conducting secure software development activities largely depends on the technology and languages employed, common languages, platforms, development environments and the unique capabilities of each will be addressed. Prerequisite: SYEG 560

SYEG 664 Advanced Cybersecurity Management (3 semester hours)
This course will focus on incorporating an enterprise approach and using sound systems engineering principles in implementing cybersecurity in today's modern highly complex and interconnected information systems. This course will provide introductions to the various cybersecurity frameworks, standards, and best practices (NIST, COBIT, ISO/IEC, NERC, HIPAA, CIS Critical Security Controls) in use by both government and commercial sectors. We will explore the benefits and limitations of each and provide detailed instruction on developing a cybersecurity risk management program that would be incorporated into an organization's overall risk profile. Focus of this course will also be placed on reporting cybersecurity metrics and incidents to the board of trustees/directors, the C-suite and other executive leadership. Emphasis will be placed on utilizing the proper business acumen to effectively communicate complex technical cyber problems and challenges. Legal and privacy considerations will be addressed as well as forensics, disaster recovery and incident response planning and management, and security education. The course will cover the importance of third party management and how service level agreements play an integral part in managing risk at the enterprise level. Tabletop exercises, guest speakers and case studies will augment lecture materials on key concepts and principles. Prerequisite: SYEG 660 (may be taken concurrently).

SYEG 668 Systems Engineering Modeling and Analysis (3 semester hours)
This course emphasizes the development of analytic modeling skills and the effective applications of operations research methods in policy, management, and planning settings. A set of widely used models including linear programming, decision analysis, queuing, and forecasting is introduced. We explore how to effectively use these models, as well as their strengths and limitations in different problem and organizational contexts. The goal of this course is to teach systems engineers, policy makers, and managers to gain analytical skills and apply them to complex problems. To this end, students will learn: 1) to structure problems so they can be effectively addressed, 2) to formulate models that are useful in different decision situations, 3) to use spreadsheet software to solve these models, and 4) to effectively present quantitative analysis to clients. Undergraduate-level statistics is recommended.

SYEG 670 Spacecraft Design (3 semester hours)

SYEG 673 New Product Design and Development (3 semester hours)
This course will provide students with an overall understanding of the concepts of entrepreneurship, designing a new product, and developing both a business plan and a prototype for that product to bring it to market. It combines MBA and engineering graduate students into trams that will decide upon a new product idea to pursue and then embark on bringing that idea to fruition. While the course is heavily experiential. it will also provide solid models of how to manage this type of function in business or technical settings. This class is not only about learning the process, but also about risk and failure; growing from those experiences and learning how to forge those experiences into workable plans and products.

SYEG 679 Startup Entrepreneurship and Managing Engineering Innovation (3 semester hours)
In a world that is driven by technological change, systems engineers are in a perfect position to understand the diverse technologies that are emerging, find innovative applications, and lead this technological revolution. This course will enable students to acquire the entrepreneurial skills necessary to develop innovative technical products/services and be able to capitalize on it. Specific topics will include 1) role of the system engineer entrepreneur, 2) finding and evaluating technological concepts, 3) building your startup team, 4) financing the startup, 5) protecting your idea, 6) negotiating effective partnerships, 7) getting it built, 8) product distribution into the marketplace, 9) growing the business, 10) planning product evolution. Course objectives will be met through lectures, discussions, readings, in-class team exercises, and applied case studies. At the conclusion of this course, students will make a presentation to venture capitalists and compete for startup funding as well as continuing support (technical, business, legal, marketing, etc.) to enable them to be successful.

SYEG 691 Systems Engineering Case Studies (3 semester hours)
Graduate students electing the thesis option must obtain a thesis advisor before departmental consent will be considered and comply with the Frank R. Seaver College of Science and Engineering Master's Thesis Requirements. Permission from academic advisor required.

SYEG 692 Thesis II (3 semester hours)
Students continue with further research and/or development of their Thesis project for a second semester. Required: Approval from academic advisor

SYEG 695 Preparation for Capstone Project (0 semester hours)
This course is typically taken prior to the SYEG 696 Integrative Project/ Thesis. The student develops a project plan, gains advisor approval, and presents the plan to a panel.

SYEG 696 Graduate Capstone Project (3 semester hours)
Capstone course in which each student working individually applies and demonstrates the mastery of the systems engineering process to a complex technical and/or social endeavor. This course should be taken in the last semester of the study program.

SYEG 698 Special Studies (0-3 semester hours)

SYEG 699 Independent Studies (1-3 semester hours)