ENGINEERING SYSTEMS (ESD)

Undergraduate

ESD.01[J] Transportation Systems Modeling
Same subject as 1.041[J]
Prereq: 1.00 or 1.000; 1.010
U (Spring)
3-1-8 units
See description under subject 1.041[J].
C. Osorio

ESD.03[J] System Safety
Same subject as 16.63[J]
Prereq: None
U (Spring)
3-0-9 units. REST
Introduces the concepts of system safety and how to analyze and design safer systems. Topics include the causes of accidents in general, and recent major accidents in particular; hazard analysis, safety-driven design techniques; design of human-automation interaction; integrating safety into the system engineering process; and managing and operating safety-critical systems.
N. Leveson

ESD.046[J] Global Environmental Science and Negotiations
Same subject as 12.346[J]
Subject meets with 12.846[J], ESD.110[J]
Prereq: Permission of instructor
U (Fall)
3-0-6 units
Practical introduction to the international environmental political arena, particularly designed for science and engineering students whose work is potentially relevant to global environmental issues. Covers basic issues in international politics, such as negotiations, North-South conflict, implementation and compliance, and trade. Emphasizes the roles and responsibilities of experts providing scientific assessment reports and in technical advisory bodies. Term projects focus on organizing and presenting scientific information in ways relevant for ongoing global policymaking. Students taking graduate version complete additional assignments.
N. Selin

ESD.05 Engineering Leadership Lab
Subject meets with ESD.050
Prereq: None. Coreq: ESD.054 or permission of instructor
U (Fall, Spring)
0-2-1 units
Can be repeated for credit.
Exposes students to engineering frameworks, models, and cases in an interactive, experience-based environment, and hones leadership skills. Students participate in guided reflection on successes and discover opportunities for improvement in a controlled setting. Activities include design-implement activities, role-playing, simulations, case study analysis, and performance assessment by and of other students. Content throughout the term is frequently student-driven. First-year GEL Program students register for ESD.05. Second-year GEL Program students register for ESD.050.
L. McGonagle, J. Magarian

ESD.050 Engineering Leadership Lab
Subject meets with ESD.05
Prereq: ESD.05
U (Fall, Spring)
0-2-4 units
Can be repeated for credit.
Exposes students to engineering frameworks, models, and cases in an interactive, experience-based environment, and hones leadership skills. Students participate in guided reflection on successes and discover opportunities for improvement in a controlled setting. Activities include design-implement activities, role-playing, simulations, case study analysis, and performance assessment by and of other students. Content throughout the term is frequently student-driven. First-year GEL Program students register for ESD.05. Second-year GEL Program students register for ESD.050.
L. McGonagle, J. Feiler

ESD.051[J] Engineering Innovation and Design
Same subject as 2.723[J], 6.902[J]
Prereq: None
U (Fall, Spring)
3-0-3 units
Project-based seminar in innovative design thinking develops students' ability to conceive, implement, and evaluate successful projects in any engineering discipline. Lectures focus on the iterative design process and techniques to enhance creative analysis. Students use this process to design and implement robust voice recognition applications using a simple web-based system. They also give presentations and receive feedback to sharpen their communication skills for high emotional and intellectual impact. Guest lectures illustrate multidisciplinary approaches to design thinking.
B. Kotelly
ESD.052 Project Engineering
Prereq: ESD.05 or permission of instructor
U (IAP)
1-2-1 units
Credit cannot also be received for 1.040

Students attend a four-day off-site workshop where an introduction to basic principles, methods, and tools for project management in a realistic context are covered. In teams, students create a plan for a project of their choice; past projects include Debris Removal in Haiti and Food Preparation Robot for Restaurants. Develops skills applicable to the management of complex development projects. Topics include cost-benefit analysis, resource and cost estimation, and project control and delivery. Case studies highlight projects in both hardware/construction and software.

O. de Weck

ESD.054 Engineering Leadership
Prereq: None. Coreq: ESD.05 or permission of instructor
U (Fall, Spring)
1-0-2 units
Can be repeated for credit.

Exposes students to the models and methods of engineering leadership within the contexts of conceiving, designing, implementing and operating products, processes and systems. Introduces models and theories, such as the Four Capabilities Framework and the Capabilities of Effective Engineering Leaders. Discusses the appropriate times and reasons to use particular models to deliver engineering success. Includes guest speakers and team projects that change from term to term. May be repeated for credit once with permission of instructor.

J. Magarian, J. Schindall, L. McGonagle

ESD.07[J] Statistical Thinking and Data Analysis
Same subject as 15.075[J]
Prereq: 6.041 or 15.079
U (Spring)
3-1-8 units. Institute LAB
See description under subject 15.075[J].

R. Mazumder

ESD.082[J] Science, Technology, and Public Policy
Same subject as 17.309[J], STS.082[J]
Prereq: None
U (Fall)
4-0-8 units. HASS-S; CI-H
Credit cannot also be received for 17.309[J], ESD.103[J], STS.082[J]

See description under subject 17.310[J].

K. Oye

ESD.101 Concepts and Research in Technology and Policy
Prereq: ESD.103[J], permission of instructor
G (Spring)
2-0-4 units

Focusing on technology and policy, explores the nature of engineering knowledge (as distinct from scientific knowledge), as well as the role of engineering systems in framing of problems. Considers implications of these concepts in the framing of research questions. Exercises aim to prepare students to apply these concepts in the framing of their thesis research.

F. Field

ESD.103[J] Science, Technology, and Public Policy
Same subject as 17.310[J], STS.482[J]
Prereq: Permission of instructor
G (Fall)
4-0-8 units
Credit cannot also be received for 17.309[J], ESD.082[J], STS.082[J]

See description under subject 17.310[J].

K. Oye

ESD.110[J] Global Environmental Science and Negotiations
Same subject as 12.846[J]
Subject meets with 12.346[J], ESD.046[J]
Prereq: None
G (Fall)
3-0-6 units

Practical introduction to the international environmental political arena, particularly designed for science and engineering students whose work is potentially relevant to global environmental issues. Covers basic issues in international politics, such as negotiations, North-South conflict, implementation and compliance, and trade. Emphasizes the roles and responsibilities of experts providing scientific assessment reports and in technical advisory bodies. Term projects focus on organizing and presenting scientific information in ways relevant for ongoing global policymaking. Students taking graduate version complete additional assignments.

N. Selin
ESD.120[J] Sustainability Science and Engineering
Same subject as 12.845[J]
Prereq: None. Coreq: ESD.83 or permission of instructor
G (Fall)
3-0-6 units
Introduces and develops core ideas and concepts in the field of sustainability science and engineering from an engineering systems perspective. Takes an interdisciplinary approach to discuss case studies of sustainability systems research. Exposes students to techniques for sustainability research across engineering, natural and social science disciplines. Term projects focus on applying techniques.
N. Selin

ESD.124 Energy Systems and Climate Change Mitigation
Prereq: Permission of instructor
G (Spring)
3-0-9 units
Explores the contributions of energy systems to global greenhouse gas emissions and the potential levers for reducing emissions. Lectures and projects focus on decomposing contributions to greenhouse gas emissions, with emphasis on technology related variables such as per unit cost and carbon intensity of energy. Reviews other performance attributes of energy technologies. Student projects explore pathways for realizing emissions reduction scenarios.
J. Trancik

ESD.125 Mapping and Evaluating New Energy Technologies
Prereq: Permission of instructor
G (Spring)
3-0-9 units
Project-based seminar covers recent developments in energy conversion and storage technologies. Merits of alternative technologies are debated based on their environmental performance and cost, and their potential improvement and scalability. Project teams develop quantitative models and interactive visualization tools to inform the future development of these technologies. Models may probe how the impact of a technology depends on assumptions about future advancements in materials or device design. Other projects may develop models for rational design choices (the selection of a particular material or processing technique) based on economic and environmental performance and physical constraints.
J. Trancik

Same subject as 12.848[J], 15.023[J]
Subject meets with 12.348[J], 15.026[J]
Prereq: Calculus II (GIR); 5.60; 14.01 or 15.010; or permission of instructor
G (Spring)
3-0-6 units
See description under subject 15.023[J].
R. G. Prinn

ESD.132 Law, Technology, and Public Policy
Prereq: Permission of instructor
G (Spring)
3-0-9 units
Examination of the relationship between law and technological change, and the ways in which law, economics, and technological change shape public policy. Areas addressed include how law can be used to influence and guide technological change; responses of the legal system to environmental, safety, social and ethical problems created by new or existing technology; how law and markets interact to limit or encourage technological development; and how law can affect the distribution of wealth and social justice. Topics covered include climate change; genetic engineering; telecommunications; industrial automation; the effect of health, safety, and environmental regulation on technological innovation; the impacts of intellectual property law on innovation and equity; pharmaceuticals; nanotechnology; cost/benefit analysis as a decision tool; public participation in governmental decisions affecting science and technology; corporate influence on technology; and law and economics as competing paradigms to encourage sustainability.
N. Ashford, C. Caldart

ESD.133[J] Environmental Law, Policy, and Economics: Pollution Prevention and Control
Same subject as 1.811[J], 11.630[J]
Subject meets with 1.801[J], 11.021[J], 17.393[J]
Prereq: Permission of instructor for undergraduates
G (Fall)
3-0-9 units
See description under subject 1.811[J].
N. Ashford, C. Caldart
ESD.134[J] Regulation of Chemicals, Radiation, and Biotechnology
Same subject as 1.812[J], 11.631[J]
Subject meets with 1.802[J], 10.805[J], 11.022[J], ESD.136[J]
Prereq: 1.811[J] or permission of instructor
G (Spring)
Not offered regularly; consult department
3-0-9 units
See description under subject 1.812[J].
N. Ashford, C. Caldart

Same subject as 10.805[J]
Subject meets with 1.802[J], 1.812[J], 11.022[J], 11.631[J], ESD.134[J]
Prereq: Permission of instructor
G (Spring)
Not offered regularly; consult department
3-0-6 units
See description under subject 10.805[J].
N. A. Ashford, C. C. Caldart

ESD.137[J] Technology, Globalization, and Sustainable Development
Same subject as 1.813[J], 11.466[J], 15.657[J]
Prereq: Permission of instructor
G (Fall)
3-0-9 units
Investigates sustainable development, taking a broad view to include not only a healthy economic base, but also a sound environment, stable employment, adequate purchasing power, distributional equity, national self-reliance, and maintenance of cultural integrity. Explores national, multinational, and international political and legal mechanisms to further sustainable development through transformation of the industrial state. Addresses the importance of technological innovation and the financial crisis of 2008.
N. Ashford

ESD.151[J] Chemicals in the Environment: Fate and Transport
Same subject as 1.725[J]
Prereq: Permission of instructor
Acad Year 2016-2017: Not offered
Acad Year 2017-2018: G (Fall)
3-0-9 units
See description under subject 1.725[J].
H. Hemond

ESD.152[J] Chemicals in the Environment: Fate and Transport
Same subject as 1.725[J]
Prereq: Permission of instructor
Acad Year 2016-2017: Not offered
Acad Year 2017-2018: G (Fall)
3-0-9 units
See description under subject 1.725[J].
H. Hemond

ESD.162[J] Engineering, Economics and Regulation of the Electric Power Sector
Same subject as 6.695[J], 15.032[J]
Prereq: Permission of instructor
G (Spring)
3-0-9 units
Provides an in-depth and interdisciplinary look at electric power systems, focusing on regulation as the link among engineering, economic, legal, and environmental viewpoints. Topics include electricity markets, incentive regulation of network issues, retail competition, tariff design, distributed generation, rural electrification, multinational electricity markets, environmental impacts, future of utilities and strategic sustainability issues under both traditional and competitive regulatory frameworks. Background in policy, microeconomics, or engineering desirable.
I. Perez-Arriaga, C. Knittel

ESD.163[J] Managing Nuclear Technology
Same subject as 22.812[J]
Prereq: Permission of instructor
Acad Year 2016-2017: G (Spring)
Acad Year 2017-2018: Not offered
3-0-9 units
See description under subject 22.812[J].
R. K. Lester

ESD.166[J] Sustainable Energy
Same subject as 1.818[J], 2.65[J], 10.391[J], 11.371[J], 22.811[J]
Subject meets with 2.650[J], 10.291[J], 22.081[J]
Prereq: Permission of instructor
G (Fall)
3-1-8 units
See description under subject 22.815[J].
M. W. Golay

ESD.174[J] Energy Technology and Policy: From Principles to Practice
Same subject as 5.00[J], 6.929[J], 10.579[J], 22.813[J]
Prereq: None
G (Spring)
3-0-6 units
See description under subject 22.813[J].
J. Deutch
ESD.192[J] Analyzing and Accounting for Regional Economic Change
Same subject as 1.284[J], 11.481[J]
Prereq: 14.03, 14.04
G (Spring)
3-0-9 units
See description under subject 11.481[J].

ESD.193[J] Regional Socioeconomic Impact Analyses and Modeling
Same subject as 1.285[J], 11.482[J]
Prereq: 11.481[J] or permission of instructor
G (Fall)
2-1-9 units
See description under subject 11.482[J].
K. R. Polenske

ESD.21[J] Transportation Systems Analysis: Performance and Optimization
Same subject as 1.200[J], 11.544[J]
Prereq: 1.010, permission of instructor
G (Fall)
3-1-8 units
See description under subject 1.200[J].
C. Osorio, J. Orlin

ESD.210[J] Transportation Systems Analysis: Demand and Economics
Same subject as 1.201[J], 11.545[J]
Prereq: Permission of instructor
G (Fall)
3-1-8 units
See description under subject 1.201[J].
M. Ben-Akiva

ESD.212[J] Demand Modeling
Same subject as 1.202[J]
Prereq: 1.201[J] or permission of instructor
G (Spring)
3-1-8 units
See description under subject 1.202[J].
M. Ben-Akiva

ESD.213[J] Advanced Demand Modeling
Same subject as 1.205[J]
Prereq: 1.202[J] or permission of instructor
Acad Year 2016-2017: Not offered
Acad Year 2017-2018: G (Fall)
3-0-9 units
See description under subject 1.205[J].
M. E. Ben-Akiva

ESD.216[J] Logistical and Transportation Planning Methods
Same subject as 1.203[J], 6.281[J], 15.073[J], 16.76[J]
Prereq: 6.041
G (Spring)
3-0-9 units
See description under subject 1.203[J].
R. C. Larson, A. I. Barnett

ESD.217[J] The Airline Industry
Same subject as 1.232[J], 15.054[J], 16.71[J]
Prereq: None
G (Fall)
3-0-9 units
See description under subject 16.71[J].
P. P. Belobaba, A. I. Barnett, C. Barnhart, R. J. Hansman, T. A. Kochan

ESD.222[J] Transportation Policy, the Environment, and Livable Communities
Same subject as 1.253[J], 11.543[J]
Subject meets with 1.153
Prereq: Permission of instructor
G (Spring)
3-0-9 units
See description under subject 1.253[J].
J. Coughlin

ESD.224[J] Planning and Design of Airport Systems
Same subject as 1.231[J], 16.781[J]
Prereq: Permission of instructor
Acad Year 2016-2017: G (Fall)
Acad Year 2017-2018: Not offered
3-0-9 units
See description under subject 1.231[J].
R. de Neufville, A. R. Odoni
ESD.225[J] Urban Transportation Planning
Same subject as 1.252[J], 11.540[J]
Prereq: Permission of instructor
G (Fall)
3-0-9 units
See description under subject 1.252[J].
F. Salvucci, M. Murga

ESD.226[J] Public Transportation Systems
Same subject as 1.258[J], 11.541[J]
Prereq: 1.201[J] or permission of instructor
G (Spring)
3-0-9 units
See description under subject 1.258[J].
Staff

ESD.251 Supply Chain Finance
Prereq: None. Coreq: ESD.260[J] or permission of instructor
G (Fall; first half of term)
2-0-4 units
Explores the linkages between supply chain management and corporate finance. Emphasizes how the supply chain creates value for both the shareholders of the company and for the stakeholders affected by the company’s operations. Sessions combine lectures and data-rich cases from the manufacturer, distributor, and retailer perspective. Topics include accounting fundamentals, financial analysis, activity-based costing, working capital management, cash flow projections, capital budgeting, and sustainability.
J. Goentzel, J. Rice

ESD.252 Supply Chain Software
Prereq: None
G (IAP)
2-0-1 units
Provides an overview of the main types of supply chain software including ERP, WMS, and TMS systems. Describes their main functionality, how they work, how they are used, their architecture, data flows, and how they are organized into modules. Also describes the software selection process and how software upgrade and implementation projects should be organized and managed.
B. Arntzen

ESD.259[J] Business Writing for Supply Chain Management
Same subject as 21W.800[J]
Prereq: None
G (Fall)
1-0-2 units
Focuses on analyzing and tailoring content for specific audiences, developing argumentation and persuasion skills, and writing clear, concise and well-structured documents (business letters, memos, executive summaries, and briefings). Covers business writing techniques and strategies through lectures and exercises, individual writing assignments, and peer reviewed workshops. In preparation for the master’s thesis requirement, students create problem statements, as well as research, write and revise a literature review.
P. Siska, B. Arntzen

ESD.260[J] Logistics Systems
Same subject as 1.260[J], 15.770[J]
Prereq: Permission of instructor
G (Fall)
3-0-9 units
Provides an introduction to supply chain management from both analytical and practical perspectives. Taking a unified approach, students develop a framework for making intelligent decisions within the supply chain. Covers key logistics functions, such as demand planning, procurement, inventory theory and control, transportation planning and execution, reverse logistics, and flexible contracting. Explores concepts such as postponement, portfolio management, and dual sourcing. Emphasizes skills necessary to recognize and manage risk, analyze various tradeoffs, and model logistics systems.
Y. Sheffi, C. Caplice

ESD.261[J] Case Studies in Logistics and Supply Chain Management
Same subject as 1.261[J], 15.771[J]
Prereq: Permission of instructor
G (Spring)
3-0-6 units
A combination of lectures and cases covering the strategic, management, and operating issues in contemporary logistics and integrated supply chain management. Includes: logistics strategy; supply chain restructuring and change management; and distribution, customer service, and inventory policy.
J. Byrnes
ESD.262 Leading Global Teams
Prereq: ESD.260[J] or permission of instructor
G (IAP)
3-0-3 units

Reinforces supply chain concepts and develops management and teamwork skills. Focuses on practical, rather than theoretical tools, methodologies, and approaches that students will use throughout their supply chain career. Includes guest lectures, a case competition, and several large-scale, team-based simulation learning games.
B. Arntzen, C. Caplice

ESD.263[J] Thesis Writing for Supply Chain Management
Same subject as 21W.801[J]
Prereq: None
G (Spring)
1-0-2 units

Writing instruction provided for thesis teams, with emphasis on thesis structure and layout. Students develop a schedule for completing thesis and prepare an executive summary of approved topic.
P. Siska

ESD.264[J] Database, Internet, and Systems Integration Technologies
Same subject as 1.264[J]
Prereq: Permission of instructor
G (Fall)
5-0-7 units

See description under subject 1.264[J].
C. Cassa

ESD.265[J] Global Supply Chain Management
Same subject as 1.265[J], 2.965[J], 15.765[J]
Prereq: 1.260[J], 1.261[J], 15.761, 15.778, or permission of instructor
G (Spring)
2-0-4 units

See description under subject 2.965[J].
B. Arntzen

ESD.266 Freight Transportation
Prereq: ESD.260[J]
G (Spring; second half of term)
2-0-4 units

Provides an in-depth introduction to the fundamental concepts and techniques related to the design, procurement, and management of freight transportation. Examines freight transportation as a bridging function for a firm, considering the physical flow of raw materials and finished goods as well as connections to suppliers and customers. Also covers how freight transportation insulates a firm’s core operations from external disruptions and variability of supply and demand.
C. Caplice, Y. Sheffi

ESD.267[J] Supply Chain Planning
Same subject as 1.273[J], 15.762[J]
Prereq: 1.260[J] or 15.761
G (Spring)
2-0-4 units

See description under subject 15.762[J].
Staff

ESD.268[J] Manufacturing System and Supply Chain Design
Same subject as 1.274[J], 15.763[J]
Prereq: 1.260[J], 15.761, or 15.778
G (Spring)
2-0-4 units

See description under subject 15.763[J].
S. C. Graves, D. Simchi-Levi

ESD.269 Supply Chain Risk Management
Prereq: None
G (Spring)
3-0-9 units

Ways to develop effective and innovative strategies for risk mitigation are introduced. Also covered are identifying methods for the enterprise to respond to disruptions that may effect it, its business eco-system and the larger economy. Teaches ways to apply the SCRM framework in industrial practice.
Y. Sheffi, J. Rice

Same subject as 1.271[J], 15.764[J]
Prereq: 15.081[J] or 6.251[J], 6.436[J]; or permission of instructor
G (Spring)
3-0-9 units
Can be repeated for credit.

See description under subject 15.764[J].
ESD.278[J] Managing Sustainable Businesses for People and Profits
Same subject as 11.383[J], 15.662[J]
Prereq: None
G (Spring)
3-6-3 units
See description under subject 15.662[J].
T. Kochan

ESD.283 Humanitarian Logistics
Subject meets with ESD.284
Prereq: None
G (Spring; first half of term)
2-0-4 units
Explores how logistics management principles apply in dynamic, resource-constrained contexts, ranging from humanitarian crisis response to international development. Class sessions combine interactive presentations, practical exercises, case discussions, and guest speakers from humanitarian organizations. Provides an introduction to supply chain concepts and the humanitarian context to accommodate students from various backgrounds.
J. Goentzel

ESD.284 Humanitarian Logistics Project
Subject meets with ESD.283
Prereq: None
G (Spring; first half of term)
2-0-7 units
Explores how logistics management principles apply in dynamic, resource-constrained contexts, ranging from humanitarian crisis response to international development. Class sessions combine interactive presentations, practical exercises, case discussions, and guest speakers from humanitarian organizations. Provides an introduction to supply chain concepts and the humanitarian context to accommodate students from various backgrounds. Team projects utilize data and information from the UN, NGOs, government agencies, and the private sector.
J. Goentzel

ESD.30[J] Engineering Apollo: The Moon Project as a Complex System
Same subject as 16.895[J], STS.471[J]
Prereq: Permission of instructor
Acad Year 2016-2017: G (Spring)
Acad Year 2017-2018: Not offered
4-0-8 units
See description under subject STS.471[J].
D. Mindell

ESD.32[J] Product Design and Development
Same subject as 2.739[J], 15.783[J]
Prereq: 2.009, 15.761, 15.778, 15.810, or permission of instructor
G (Spring)
3-3-6 units
Credit cannot also be received for ESD.40
See description under subject 15.783[J].
S. Eppinger, M. C. Yang

ESD.341[J] Architecting & Engineering Software Systems
Same subject as 1.125[J]
Prereq: 1.00, 1.124[J], or permission of instructor
G (Fall)
3-0-9 units
Software architecting and design of software-intensive systems. Targeted at future CTOs who must understand both the business and technical issues involved in architecting enterprise-scale systems. Student teams confront technically challenging problems. Lectures and readings cover core database, XML, web server components and browser issues in a distributed web service environment.
J. Williams

ESD.344 Real Options for Product and Systems Design
Prereq: None
G (Spring; second half of term)
3-0-3 units
Studies the theory and practice of implementing flexibility (real options) in the design of products and systems. Topics include recognition of uncertainty, identification of best opportunities for flexibility, and valuation of these options and their effective implementation. Enables effective and efficient adaptation to future changes. Students apply the concepts by working in teams on an ongoing product development project. Final product is an advanced, dynamic business plan for design and deployment of products.
R. de Neufville

ESD.351[J] Air Transportation Systems Architecting
Same subject as 16.886[J]
Prereq: Permission of instructor
G (Fall)
3-2-7 units
See description under subject 16.886[J].
R. J. Hansman
ESD.352[J] Space Systems Engineering  
Same subject as 16.89[J]  
Prereq: 16.851 or permission of instructor  
Acad Year 2016-2017: Not offered  
Acad Year 2017-2018: G (Spring)  
4-2-6 units  
See description under subject 16.89[J].  
J. A. Hoffman

Same subject as 16.355[J]  
Prereq: Permission of instructor  
G (Fall)  
3-0-9 units  
See description under subject 16.355[J].  
N. G. Leveson

ESD.38[J] Systems Architecting Applied to Enterprises  
Same subject as 16.855[J]  
Prereq: Permission of instructor  
G (Spring)  
3-0-9 units  
Principles and practices used in systems architecting are presented, adapted and extended to design a future architecture for an enterprise undergoing change. Uses case-based exercises and examples. Team projects investigate a real-world enterprise from multiple perspectives and apply architecting and design techniques. Topics include theories, frameworks, and methods for generating and evaluating alternative architectures, selecting a preferred future state architecture, and developing implementation strategies.  
D. Rhodes

ESD.39 Systems, Leadership, and Management Lab (SLaM-Lab)  
Prereq: 15.905 or permission of instructor  
G (Fall)  
3-3-3 units  
Focuses on the practical means for integrating leadership and systems and engineering approaches to solve real-world problems. In addition to classroom learning and exercises, students work one day a week with the top management of a high-tech business on a relevant systems and management challenge. The host company sets the project focus. Project teams of four to six students help to solve a problem that is of concern to the host company.  
M. Davies

ESD.40 Product-System Design  
Prereq: Permission of instructor  
G (Spring)  
3-0-9 units  
Credit cannot also be received for 2.739[J], 15.783[J], ESD.32[J]  
Modern tools and methods for product design and development. Teams conceive, design, and prototype a physical product. Cases and exercises reinforce key ideas. Topics include product planning, identifying customer needs, concept generation/selection, product architecture, industrial design, concept design, and design-for-manufacturing.  
M. Yang, P. Hale

ESD.411 Foundations of System Design and Management  
Prereq: Permission of instructor  
G (Fall)  
4-2-10 units  
Presents the foundations of systems architecture, systems engineering and project management in an integrated format, through a synchronized combination of in-class discussion, industrial guest speakers, team projects, and individual assignments. Topics include stakeholder analysis, project planning and monitoring, requirements definition, concept generation and selection, complexity management, system integration, verification and validation, cost modeling, systems safety, organizational design and effective teamwork, risk management, and leadership styles.  
O. de Weck, B. Cameron, B. Moser

ESD.412 Foundations of System Design and Management II  
Prereq: ESD.411  
G (IAP)  
2-1-3 units  
Deepens the foundations of systems architecture, systems engineering and project management introduced in ESD.411 through a synchronized combination of lectures, recitations, opportunity sets, guest speakers, and team projects. Topics emphasize the transition from early conceptual design to detailed design and system integration. Features a technology showcase and project forum where students, faculty and company sponsors meet to discuss and select projects for ESD.413. Includes team-based exercises and design challenges.  
O. de Weck, B. Cameron, B. Moser
ESD.413 Foundations of System Design and Management III
Prereq: ESD.412
G (Spring)
4-2-10 units

Presents advanced concepts in systems architecture, systems engineering and project management in an integrated manner through lectures, recitations, opportunity sets, guest lectures, and a semester-long team project. Topics emphasize complexity management, systems integration, verification, validation, and lifecycle management. Specific lifecycle properties addressed include quality, safety, robustness, resilience, flexibility and evolvability of systems over time. Additional topics include monitoring and control, the rework cycle, managing portfolios and programs of projects in a multi-cultural and global context, and managing product families and platforms.

O. de Weck, B. Cameron, B. Moser

ESD.441 Integrated Design Lab I
Prereq: Permission of instructor
G (Fall)
5-6-7 units

Presents fundamentals of the integrated design and product development process. Covers methods relevant at each stage of the process; students apply them in a series of design projects. Topics include stakeholder identification, customer engagement and ethnographic methods, concept generation and selection, project planning, manufacturing methods, supply systems, cost modeling, sustainability, and safety.

M. Kressy, S. Eppinger, W. Seering

ESD.442 Integrated Design Lab II
Prereq: ESD.441 or permission of instructor
G (Spring)
5-6-7 units

Presents advanced topics in integrated design and product development. Students pursue a product development project as a case study for understanding how teams work together to define and test a new product. Provides exposure to the state-of-the-art in product definition, product architectures, market testing, competitive analysis, product planning strategy, business case construction, and life cycle design. Students apply their previously acquired product development knowledge and engage in ongoing reflection in an action-oriented setting.

M. Kressy, S. Eppinger, W. Seering

ESD.51[J] Software and Computation for Simulation
Same subject as 1.124[J], 2.091[J]
Prereq: 1.00 or permission of instructor
G (Fall)
Not offered regularly; consult department
3-0-9 units

See description under subject 1.124[J].
J. R. Williams

ESD.53[J] Globalization and the Built Environment
Same subject as 1.463[J], 11.342[J]
Prereq: Permission of instructor
G (Fall)
Not offered regularly; consult department
2-0-4 units

See description under subject 1.463[J].
F. Moavenzadeh, D. Wolff

Same subject as 15.565[J]
Prereq: Permission of instructor
G (Fall)
3-0-6 units

See description under subject 15.565[J].
S. Madnick

ESD.60 Creating High-Velocity Organizations
Prereq: Permission of instructor
G (Summer)
2-0-6 units

Covers basic principles for system design, operation, and improvement. Focuses on standout organizations that deliver more value at greater speed, and with less effort and cost, than their counterparts. Emphasizes speed and rigorous experimentation. Draws examples from heavy and high-tech manufacturing, new product development, healthcare, and the military.

S. Spear

ESD.61[J] Integrating The Lean Enterprise
Same subject as 16.852[J]
Prereq: Permission of instructor
G (Fall)
3-0-9 units

See description under subject 16.852[J].
Staff
ESD.63[J] Control of Manufacturing Processes
Same subject as 2.830[J], 6.780[J]
Prereq: 2.008, 6.041, 6.152[J], or 15.064[J]
G (Spring)
3-0-9 units
See description under subject 2.830[J].
D. E. Hardt, D. S. Boning

ESD.64[J] Product Design
Same subject as 2.744[J]
Prereq: 2.009
Acad Year 2016-2017: Not offered
Acad Year 2017-2018: G (Spring)
3-0-9 units
See description under subject 2.744[J].
D. R. Wallace

ESD.65[J] Aerospace Biomedical and Life Support Engineering
Same subject as 16.423[J], HST.515[J]
Prereq: 16.400, 16.06, or permission of instructor
Acad Year 2016-2017: G (Spring)
Acad Year 2017-2018: Not offered
3-1-8 units
See description under subject 16.423[J].
D. J. Newman

ESD.69[J] Seminar on Health Care Systems Innovation
Same subject as HST.926[J]
Prereq: Permission of instructor
G (Fall)
2-0-7 units
Seminar examines how "systems" approaches can be used to address inefficiencies and introduction of innovation into the delivery of health care. Topics include identification of problems in delivery of chronic, acute, and emergency care and possible organizational and technological solutions. Cases, readings, and discussions draw upon experiences in the United States and globally.
S. Finkelstein, J. Moses, J. Coughlin

ESD.691[J] Principles and Practice of Drug Development
Same subject as 7.547[J], 10.547[J], 15.136[J], HST.920[J]
Prereq: Permission of instructor
G (Fall)
3-0-6 units
See description under subject 15.136[J].
T. J. Allen, C. L. Cooney, S. N. Finkelstein, A. J. Sinskey, G. K. Raju

ESD.70[J] Engineering Economy Module
Same subject as 1.145[J]
Prereq: None
G (Fall; partial term)
1-0-2 units
Presentation of the spreadsheet mechanics for the efficient calculation of discounted cash flows and related metrics of project worth; the use of data tables as means of exploring sensitivity analysis; and of simulation to develop the value of options. Intensive module designed for students who are not familiar with the efficient use of Excel. Presented intensively over first week of term.
R. de Neufville

ESD.71 Engineering Systems Analysis for Design
Engineering School-Wide Elective Subject.
Offered under: 1.146, 16.861, ESD.71
Subject meets with ESD.710
Prereq: 1.145[J] or permission of instructor
G (Fall)
3-0-9 units
Covers theory and methods to identify, value, and implement flexibility in design, also known as "real options." Topics include definition of uncertainties, simulation of performance for scenarios, screening models to identify desirable flexibility, decision and lattice analysis, and multidimensional economic evaluation. Students demonstrate proficiency through an extended application to a systems design of their choice. Provides a complement to research or thesis projects. Meets with ESD.710 first half of term.
R. de Neufville

ESD.710 Risk and Decision Analysis
Subject meets with 1.146[J], 16.861[J], ESD.71[J]
Prereq: 1.145[J] or permission of instructor
G (Fall; first half of term)
3-0-3 units
Focuses on design choices and decisions under uncertainty. Topics include identification and description of uncertainties using probability distributions; the calculation of commensurate measures of value, such as expected net present values; Monte Carlo simulation and risk analysis; and the use of decision analysis to explore alternative strategies and identify optimal initial choices. Applied analysis of practical examples from a variety of engineering systems using spreadsheet and decision analysis software.
R. de Neufville
ESD.712[J] Tools for Analysis: Design for Real Estate and Infrastructure Development
Same subject as 11.434[J], 15.428[J]
Prereq: None
G (Spring; second half of term)
2-0-4 units
See description under subject 11.434[J].
D. Geltner, R. de Neufville

ESD.73[J] Materials Selection, Design, and Economics
Same subject as 3.57[J]
Prereq: Permission of instructor
G (Fall)
3-0-6 units
See description under subject 3.57[J].
J. Clark

ESD.750[J] System Optimization and Analysis for Operations
Same subject as 2.851[J], 15.066[J]
Prereq: Calculus II (GIR)
G (Summer)
4-0-8 units
See description under subject 15.066[J].
V. Farias

ESD.751[J] Engineering Probability and Statistics
Same subject as 15.064[J]
Prereq: Calculus II (GIR)
G (Summer)
4-0-8 units
See description under subject 15.064[J].
A. I. Barnett, R. E. Welsch

ESD.753[J] Statistical Learning and Data Mining
Same subject as 15.077[J]
Prereq: 6.431, 15.085[J], or 18.600; 18.06 or 18.700
G (Spring)
4-0-8 units
See description under subject 15.077[J].
R. E. Welsch

ESD.754[J] Data Mining: Finding the Data and Models that Create Value
Same subject as 15.062[J]
Subject meets with 15.0621
Prereq: 15.060 or 15.075[J]
G (Fall; second half of term)
2-0-4 units
See description under subject 15.062[J].
R. E. Welsch

ESD.755[J] Predictive Data Analytics and Statistical Modeling
Same subject as 15.074[J]
Prereq: 6.431, 15.060, or permission of instructor
G (Spring)
4-0-5 units
Credit cannot also be received for 15.0741
See description under subject 15.074[J].
R. E. Welsch

ESD.756[J] Statistical Methods in Experimental Design
Same subject as 16.470[J]
Prereq: 6.041, 16.09, or permission of instructor
Acad Year 2016-2017: Not offered
Acad Year 2017-2018: G (Spring)
3-0-9 units
See description under subject 16.470[J].
C. L. Carr

ESD.762[J] Business and Operations Analytics
Same subject as 1.275[J]
Prereq: 1.145[J] or permission of instructor
G (Spring; first half of term)
2-0-4 units
Provides instruction on identifying, evaluating, and capturing business analytics opportunities that create value. Also provides basic instruction in analytics methods and case study analysis of organizations that successfully deployed these techniques.
D. Simchi-Levi
ESD.77[J] Multidisciplinary System Design Optimization
Same subject as 16.888[J]
Prereq: 18.085 or permission of instructor
Acad Year 2016-2017: Not offered
Acad Year 2017-2018: G (Spring)
3-1-8 units


O. de Weck

ESD.773[J] Human Systems Engineering
Same subject as 16.453[J], HST.518[J]
Subject meets with 16.400
Prereq: 6.041, 16.09, or permission of instructor
G (Fall)
3-1-8 units

See description under subject 16.453[J].

L. A. Stirling

ESD.774[J] Human Supervisory Control of Automated Systems
Same subject as 16.422[J]
Prereq: Permission of instructor
Acad Year 2016-2017: Not offered
Acad Year 2017-2018: G (Fall)
3-1-8 units

See description under subject 16.422[J].

J. A. Shah

ESD.775[J] Human-Computer Interface Design Colloquium
Same subject as 16.475[J]
Prereq: None
G (Fall)
2-0-2 units

See description under subject 16.475[J].

Staff

ESD.78[J] Network Optimization
Same subject as 15.082[J]
Prereq: 15.081[J] or permission of instructor
G (Fall)
3-0-9 units

See description under subject 15.082[J].

J. Orlin

ESD.80 Seminar in Technology Policy Research
Prereq: ESD.101
G (Spring)
2-0-1 units

Presentations by students, faculty and guest speakers of ongoing research related to current issues in technology and policy. Specific topics determined by research of participants and by new and important directions in technology and policy.

J. Clark

ESD.801 Leadership Development
Prereq: Permission of instructor
G (Fall; partial term)
1-1-1 units

Seminar environment created to develop leadership capabilities, and to take advantage of leadership opportunities. An initial Outward Bound experience builds trust, teamwork and communications. Readings and assignments emphasize the characteristics of desired leadership skills. Global leaders participate in the Leadership Lunch series to share their experiences and recommendations. Discussions explore leadership development. Culminates in a personal leadership plan.

B. Moser

ESD.811 Technology Policy Internship Seminar
Prereq: ESD.101 or permission of instructor
G (Fall)
1-1-1 units
Can be repeated for credit.

Seminar examines what technology policy is in practice. Considers the question of "Who achieves what, when, how, and why?" regarding technology policy. Students who completed summer internships present and dissect their experiences with special reference to specific cases in which they participated.

F. Field
ESD.83 Doctoral Seminar in Engineering Systems
Prereq: Permission of instructor
G (Fall)
4-0-8 units
Examines core theory and contextual applications of the emerging field of Engineering Systems. Focuses on analysis of scholarship on key concepts such as complexity, uncertainty, fragility, and robustness, as well as a critical look at the historical roots of the field and related areas such as systems engineering, systems dynamics, agent modeling, and systems simulations. Contextual applications range from aerospace to technology implementation to regulatory systems to large-scale systems change. Special attention to the interdependence of social and technical dimensions of engineering systems.
Information: E. Milnes

ESD.863[J] System Safety Concepts
Same subject as 16.863[J]
Prereq: Permission of instructor
G (Spring)
3-0-9 units
See description under subject 16.863[J].
N. G. Leveson

ESD.864[J] Modeling and Assessment for Policy
Same subject as 12.844[J]
Prereq: None
G (Spring)
3-0-6 units
Explores how scientific information and quantitative models can be used to inform policy decision-making. Develops an understanding of quantitative modeling techniques and their role in the policy process through case studies and interactive activities. Addresses issues such as analysis of scientific assessment processes, uses of integrated assessment models, public perception of quantitative information, methods for dealing with uncertainties, and design choices in building policy-relevant models. Examples focus on models and information used in Earth system governance.
N. Selin

ESD.87 Social Science Concepts and Methods
Prereq: ESD.83 or permission of instructor
G (Fall)
3-0-9 units
Introduction to social science approaches to developing questions, designing research, and collecting data about complex systems. Overview of the different social science paradigms for developing research questions, as well as issues of measurement and research design. Covers various modes of data collection with emphasis on how the different elements of research design contribute to more powerful and persuasive results. Students develop skills in designing and completing social science-based research, as well as in critically assessing related work.
L. D’Ambrosio

Special Subjects and Research

ESD.910, ESD.915 Research in Engineering Systems Division
Prereq: Permission of instructor
G (Fall, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit.
For research assistants in the Engineering Systems Division when assigned research is not used for thesis, but is approved for academic credit. Credit for this subject may not be used for any degree granted by ESD.
Information: M. Dahleh

ESD.911-ESD.913 Independent Study in Engineering Systems
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Units arranged [P/D/F]
Individual research: generally either study, fieldwork, or practicum. Designed to expose student to expert-level material in his/her research domain or context. Supervised by a member of MIT’s teaching staff.
Information: M. Dahleh
ESD.921 Teaching in Engineering Systems Division
Prereq: Permission of instructor
G (Fall, IAP, Spring)
Units arranged [P/D/F]
Can be repeated for credit.

For teaching assistants in Engineering Systems Division in recognition of educational value derived from satisfactory performance of assigned duties, and for other qualified students interested in teaching as a career. Laboratory, tutorial, or classroom teaching under supervision of a faculty member. Credit for this subject may not be used for any degree granted by ESD.
Information: M. Dahleh

ESD.S01 Special Undergraduate Subject in Engineering Systems Division
Prereq: Permission of instructor
U (Fall, IAP, Spring, Summer)
Not offered regularly; consult department
Units arranged
Can be repeated for credit.

Opportunity for study of topics in Engineering Systems Division not otherwise included in the curriculum at MIT. Offerings are initiated by faculty on an ad-hoc basis subject to ESD approval.
Information: M. Dahleh

ESD.S02 Special Undergraduate Subject in Engineering Systems Division
Prereq: Permission of instructor
U (Fall, IAP, Spring, Summer)
Not offered regularly; consult department
Units arranged
Can be repeated for credit.

Opportunity for study of topics in Engineering Systems Division not otherwise included in the curriculum at MIT. Offerings are initiated by faculty on an ad-hoc basis subject to ESD approval.
Information: M. Dahleh

ESD.S03 Special Undergraduate Subject in Engineering Systems Division
Prereq: Permission of instructor
U (Fall, IAP, Spring, Summer)
Not offered regularly; consult department
Units arranged
Can be repeated for credit.

Opportunity for study of topics in Engineering Systems Division not otherwise included in the curriculum at MIT. Offerings are initiated by faculty on an ad-hoc basis subject to ESD approval.
Information: M. Dahleh

ESD.S10 Special Undergraduate Subject in Engineering Systems Division
Prereq: Permission of instructor
U (Fall, IAP, Spring, Summer)
Not offered regularly; consult department
Units arranged [P/D/F]
Can be repeated for credit.

Opportunity for study of topics in Engineering Systems Division not otherwise included in the curriculum at MIT. Offerings are initiated by faculty on an ad-hoc basis subject to ESD approval.
Information: M. Dahleh

ESD.S11 Special Undergraduate Subject in Engineering Systems Division
Prereq: Permission of instructor
U (Fall, IAP, Spring, Summer)
Not offered regularly; consult department
Units arranged [P/D/F]
Can be repeated for credit.

Opportunity for group study of topics in Engineering Systems Division not otherwise included in the curriculum at MIT. Offerings are initiated by faculty on an ad-hoc basis subject to ESD approval.
Information: M. Dahleh

ESD.S20-ESD.S22 Special Graduate Subject in Engineering Systems Division
Prereq: Permission of instructor
G (Fall)
Units arranged
Can be repeated for credit.

Opportunity for study of advanced topics in Engineering Systems Division not otherwise included in the curriculum at MIT. Offerings are initiated by faculty on an ad-hoc basis subject to ESD approval.
Fall: C. Cassa
Spring: Information: M. Dahleh

ESD.S23 Special Graduate Subject in Engineering Systems Division
Prereq: Permission of instructor
G (Spring)
Units arranged
Can be repeated for credit.

Opportunity for study of advanced topics in Engineering Systems Division not otherwise included in the curriculum at MIT. Offerings are initiated by faculty on an ad-hoc basis subject to ESD approval.
Information: M. Dahleh
ESD.S24 Special Graduate Subject in Engineering Systems
Division
Prereq: Permission of instructor
G (Spring)
Units arranged
Can be repeated for credit.

Opportunity for study of advanced topics in Engineering Systems Division not otherwise included in the curriculum at MIT. Offerings are initiated by faculty on an ad-hoc basis subject to ESD approval.

Information: M. Dahleh

ESD.S30-ESD.S31 Special Graduate Studies in Engineering Systems Division
Prereq: None
G (Fall, IAP, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit.

Opportunity for individual or group study of advanced topics in Engineering Systems Division not otherwise included in the curriculum at MIT. Offerings are initiated by faculty on an ad-hoc basis subject to ESD approval.

Information: M. Dahleh

ESD.S32 Special Graduate Studies in Engineering Systems Division
Prereq: None
G (Spring)
Units arranged [P/D/F]
Can be repeated for credit.

Opportunity for individual or group study of advanced topics in Engineering Systems Division not otherwise included in the curriculum at MIT. Offerings are initiated by faculty on an ad-hoc basis subject to ESD approval.

Information: M. Dahleh

ESD.THG ESD Graduate Thesis
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit.

Program of research, leading to the writing of an SM or PhD thesis to be arranged by the student with a member of the ESD faculty. A minimum of 24 thesis units are required for the SM degree.

Information: M. Dahleh

ESD.URG Undergraduate Research
Prereq: None
U (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit.

Undergraduate research opportunities in Engineering Systems.

Information: M. Dahleh