

SUSTAINABLE PRODUCT DEVELOPMENT

Course Description

The aim of this course is to focus on techniques and strategies for development of sustainable products and manufacturing processes. This course will help students to examine strategic decisions and best practices in new product and process development when environmental and resource externalities are accounted for by using book reading, case studies and research papers. Students will study the industrial ecology and life cycle assessment techniques in integrating traditional product and process development requirements with those of the environment and society. The emphasis in this course is on sustainability requirements in management of new product and process development from the perspective of the senior-level executive who is responsible for the firm's business and operational strategies. Student teams will develop a new sustainable product or undertake field study projects to gain firsthand experience with sustainability practices in a company.

Course Objectives

The objectives of this course are:

- To develop an awareness of the need for sustainable development and the challenges/opportunities for business sustainability.
- To develop an understanding of the state-of-the-art practices in sustainable product development and manufacturing including industrial ecology, life cycle assessment and modeling techniques.
- To develop awareness of the evolution of environmental sustainability concepts and associated governmental regulations and business response on a global scale.
- To gain an appreciation of the complexities associated with operationalizing sustainability in the framework of traditional business models for assessing return on investment in new products, production and operational initiatives.

Recommended Books:

- Sustainable Product Design and Development (First edition) by Anoop Desai and Anil Mital
- Green Manufacturing : Fundamentals and Applications by David A. Dornfeld
- Green Design and Manufacturing for Sustainability (1st Edition) by Nand K. Jha
- Sustainable Food Systems from Agriculture to Industry by Valentina Siracusa

and Marco Dalla Rosa

- The Future of Packaging : From Linear to Circular.

Additional Readings

- Case study (Harvard Business Publishing)
- Research papers

Week No	Week/ Topic	Detail	Reference Book/ Case study
1	Introduction to sustainable product and service design	▪ Definition of Sustainability ▪ Definition of Design and the Engineering ▪ What is Design Review ▪ Designing a Product for Functionality ▪ Designing a Product for Usability ▪ Rules of Sustainable Product Design	Sustainable Product Design and Development by Anoop Desai and Anil Mital
2	Opportunity areas and identification	▪ To analyze competitive advantage and industry change in the context of drastic technology change ▪ To analyze entry into a mature market with a sustainable technology ▪ To analyze the strategic choice of technology in a new market.	Case Study: <i>Tesla Motors (Harvard Business Publishing)</i>
3	Environmental Legislations	▪ Environmental Legislations around the World ▪ Laws Dealing with	Sustainable Product Design and Development by Anoop Desai and

		Disposal of Electronic Waste	Anil Mital
4	Creativity and innovation in sustainable product development	▪ The interaction of creativity, innovation and sustainability is gaining momentum ▪ This article shows a conceptual framing of creativity, innovation and sustainability ▪ Ideas for how to solve environmental and social problems with implications for sustainability.	Research paper Creativity, Innovation, Sustainability: A Conceptual Model for Future Research Efforts by Alexander Brem and Rogelio Puente-Díaz
5	Economics of Sustainable Engineering	▪ Life Cycle Cost Analysis ▪ Efficiency and Life Cycle Cost Calculation ▪ Mechanics of Time Value of Money ▪ Economic Project Selection	Green Design and Manufacturing for Sustainability by Nand K. Jha
6	Analytical Techniques for Sustainability Analysis	▪ Optimal Design ▪ Selection of Optimal Shape ▪ Multiobjective Optimization	Green Design and Manufacturing for Sustainability by Nand K. Jha
7	Design for Disassembly	▪ Disassembly Process Planning ▪ Product Modularization for Disassembly: Design Approach to Disassembly ▪ Disassembly Algorithms	Sustainable Product Design and Development by Anoop Desai and Anil Mital

		and Sequence Plans: Reactive Approach to Disassembly ▪ Using Predetermined Motion Time Systems (PMTS) to Evaluate Ease of Disassembly	
8	Design for Assembly.	▪ Importance of the Assembly Process ▪ Definition of Design for Assembly ▪ Types of Assembly Methods ▪ Different Modes of Assembly and Design Guidelines to Facilitate Them ▪ Methodologies for Evaluating DfA	Sustainable Product Design and Development by Anoop Desai and Anil Mital
9	MID EXAM		
10	Circular Economy: Consideration of Reuse and Recycling	▪ What is Product Reuse? ▪ Product Modularization for Ease of Reuse ▪ What is Recycling ▪ Types of Recycling ▪ Components of a Recycling System ▪ Design for Recycling ▪ Assessing Recyclability ▪ Manual Material Separation versus Mechanical Separation - Design Guidelines for	Sustainable Product Design and Development by Anoop Desai and Anil Mital

		Material Separation	
11	Circular Economy: Consideration of Remanufacturing	▪ What is Remanufacturing ▪ Comparing Products that Have Been Remanufactured, Recycled, Reconditioned and Repaired ▪ What Type of Products Can be Remanufactured ▪ Conditions Necessary for Remanufacturing to be Profitable ▪ Types of Remanufacturers ▪ Benefits of Remanufacturing	Sustainable Product Design and Development by Anoop Desai and Anil Mital
12	Costing for Sustainable Product Design	▪ Basic Definitions and Types of Cost ▪ Mathematical Models to Predict Development Costs for Various End-of-Life Options	Sustainable Product Design and Development by Anoop Desai and Anil Mital
13	Principles for flexible and agile manufacturing	▪ One-piece-flow ▪ Just-in-time (JIT) ▪ Single Minute Exchange of Die (SMED) ▪ Workstation design and ergonomics ▪ “Fool-proof” systems (Poka-Yokes) ▪	Green Manufacturing : Fundamentals and Applications by David A. Dornfeld

14	Sustainable manufacturing System	▪ Closed loop production systems ▪ Closed-loop production systems strive for sustainability by improving economic and environmental goals simultaneously. ▪ The concept of sustainable supply chain networks (SSCN) as a suitable means of designing closed-loop production systems Game on Sustainable Manufacturing and Supply Chain Operations	Green Manufacturing : Fundamentals and Applications by David A. Dornfeld
15	Green packaging	▪ Packaging Materials in the Industry ▪ Balance between shapes and functions of packaging materials ▪ Bio-Based and Biodegradable ▪ Packaging Materials ▪ Edible Food Packaging Materials ▪ Performance and packaging applications ▪ Performances and Packaging ▪ Applications	Sustainable Food Systems from Agriculture to Industry by <u>Valentina Siracusa</u> and <u>Marco Dalla Rosa</u>

16	Sustainability Marketing in Product Development	▪ ▪ This case is about sustainability marketing, and the stages of new product development. ▪ It can also be used to teach the basics of sustainable development and the 3Ps (people, planet, and profit). ▪ After working through the case, students will have a better understanding of new product development; sustainable development and the triple bottom line, commonly referred to as the 3Ps; and sustainability marketing.	Case Study: Bakeys Cutlery: An Innovative Sustainable Product (Harvard Business Publishing)
17	Project Presentation		
18	Final Exam		