

Condensed CDIO+EL Syllabus
Version 2.1
October 2009

Suggestions for revision of Syllabus
Entrepreneurship and Leadership are added only as part of the CDIO+EL Syllabus

Clarifications, modifications and additions to core CDIO Syllabus, indicated in red,
Additions that make it the CDIO+EL Syllabus (Entrepreneurship, Leadership) in blue
Coordinated with UNESCO four pillars in green

- 1 DISCIPLINARY KNOWLEDGE AND REASONING (was TECHNICAL KNOWLEDGE AND REASONING) (UNESCO: Learning to know)
 - 1.1 KNOWLEDGE OF UNDERLYING MATHEMATICS AND SCIENCES [a]
 - 1.2 CORE ENGINEERING FUNDAMENTAL KNOWLEDGE [a]
 - 1.3 ADVANCED ENGINEERING FUNDAMENTAL KNOWLEDGE, METHODS AND TOOLS [k]
- 2 PERSONAL AND PROFESSIONAL SKILLS AND ATTRIBUTES (UNESCO: Learning to be)
 - 2.1 ANALYTICAL REASONING AND PROBLEM SOLVING (was ENGINEERING REASONING AND PROBLEM SOLVING) [e]
 - 2.1.1 Problem Identification and Formulation
 - 2.1.2 Modeling
 - 2.1.3 Estimation and Qualitative Analysis
 - 2.1.4 Analysis With Uncertainty
 - 2.1.5 Solution and Recommendation
 - 2.2 EXPERIMENTATION, INVESTIGATION AND KNOWLEDGE DISCOVERY [b]
 - 2.2.1 Hypothesis Formulation
 - 2.2.2 Survey of Print and Electronic Literature
 - 2.2.3 Experimental Inquiry
 - 2.2.4 Hypothesis Test, and Defense
[Revise text one layer down to include the issues of human and social science research]
 - 2.3 SYSTEM THINKING
 - 2.3.1 Thinking Holistically
 - 2.3.2 Emergence and Interactions in Systems
 - 2.3.3 Prioritization and Focus
 - 2.3.4 Trade-offs, Judgment and Balance in Resolution
 - 2.4 ATTITUDES, THOUGHT AND LEARNING (was PERSONAL SKILLS AND ATTITUDES)
 - 2.4.1 Initiative and the Willingness to Make Decisions in the Face of Uncertainty (was Initiative and Willingness to Take Risks)
 - 2.4.2 Perseverance, resourcefulness, flexibility, responsibility, and will and urgency to deliver (was Perseverance and Flexibility)
 - 2.4.3 Creative Thinking
 - 2.4.4 Critical Thinking
 - 2.4.5 Self-awareness, Meta-cognition and Knowledge Integration (was Awareness of One's Personal Knowledge, Skills, and Attitudes)
 - 2.4.6 Lifelong Learning and Educating Others [i] (was Curiosity and Lifelong Learning)
 - 2.4.7 Time and Resource Management
 - 2.5 ETHICS, RESPONSIBILITY, EQUITY, AND CORE PERSONAL VALUES (was PROFESSIONAL SKILLS AND ATTITUDES)
 - 2.5.1 Ethics, Integrity and Social Responsibility [f] (was Ethics, Integrity, Responsibility and Accountability)
 - 2.5.2 Professional Behavior and Responsibility [f]
 - 2.5.3 Proactively Planning for One's Career
 - 2.5.4 Staying Current on the World of Engineering
 - 2.5.5 Equity and Diversity
 - 2.5.6 Trust and Loyalty
 - 2.5.7 Vision and Intention in Life

- 3 INTERPERSONAL SKILLS: TEAMWORK AND COMMUNICATION (UNESCO: Learning to live together)
 - 3.1 TEAMWORK [d]
 - 3.1.1 Forming Effective Teams
 - 3.1.2 Team Operation
 - 3.1.3 Team Growth and Evolution
 - 3.1.4 Team Leadership (was leadership)
 - 3.1.5 Technical and Multi-disciplinary Teaming (was Technical Teaming)
 - 3.2 COMMUNICATIONS [g]
 - 3.2.1 Communications Strategy
 - 3.2.2 Communications Structure
 - 3.2.3 Written Communication
 - 3.2.4 Electronic/Multimedia Communication
 - 3.2.5 Graphical Communication
 - 3.2.6 Oral Presentation (was Oral Presentation and Inter-Personal Communications)
 - 3.2.7 Inquiry, Listening and Dialog
 - 3.2.8 Negotiation, Compromise and Conflict Resolution
 - 3.2.9 Advocacy
 - 3.2.10 Establishing Diverse Connections, networking
 - 3.3 COMMUNICATIONS IN A FOREIGN LANGUAGE
 - 3.3.1 Communications in English
 - 3.3.2 Communications in languages of regional industrial nations (was incorrectly "of the EU")
 - 3.3.3 Communications in other languages (was incorrectly "outside the EU")
- 4 CONCEIVING, DESIGNING, IMPLEMENTING, AND OPERATING SYSTEMS IN THE ENTERPRISE, SOCIETAL AND ENVIRONMENTAL CONTEXT – INNOVATION (UNESCO: Learning to do)
 - 4.1 EXTERNAL, SOCIETAL, ECONOMIC AND ENVIRONMENTAL CONTEXT [h]
 - 4.1.1 Roles and Responsibility of Engineers
 - 4.1.2 The Impact of Engineering on Society and the Environment
 - 4.1.3 Society's Regulation of Engineering
 - 4.1.4 The Historical and Cultural Context
 - 4.1.5 Contemporary Issues and Values [j]
 - 4.1.6 Developing a Global Perspective [will be expanded to place more emphasis on international work and learning]
 - 4.1.7 Sustainability and the need for sustainable development
 - 4.2 ENTERPRISE AND BUSINESS CONTEXT
 - 4.2.1 Appreciating Different Enterprise Cultures
 - 4.2.2 Enterprise Stakeholders, Strategy and Goals (was Enterprise Strategy, Goals, and Planning)
 - 4.2.3 Technical Entrepreneurship (Expanded in 4.8 of the CDIO+LE Syllabus)
 - 4.2.4 Working in Organizations (the word "successfully" omitted)
 - 4.2.5 Engineering Project Finance and Economics (added, was in 4.2.2.)
 - 4.2.6 New Technology Development, Assessment and Infusion (added, was in 4.2.2)
 - 4.2.7 Working in international organizations (added)
 - 4.3 CONCEIVING, SYSTEMS ENGINEERING AND MANAGEMENT (WAS CONCEIVING AND ENGINEERING SYSTEMS) [c]
 - 4.3.1 Understanding Needs and Setting Goals (was Setting System Goals and Requirements)
 - 4.3.2 Defining Function, Concept and Architecture
 - 4.3.3 Modeling of System and Insuring Goals Can Be Met
 - 4.3.4 System Engineering and Development Project Management (was Development Project Management)
 - 4.4 DESIGNING [c]
 - 4.4.1 The Design Process
 - 4.4.2 The Design Process Phasing and Approaches
 - 4.4.3 Utilization of Knowledge in Design
 - 4.4.4 Disciplinary Design
 - 4.4.5 Multidisciplinary Design
 - 4.4.6 Design for Sustainability, Safety, Operability, Aesthetics and other Objectives (was Multi-Objective Design (DFX))
 - 4.5 IMPLEMENTING [c]
 - 4.5.1 Designing a Sustainable Implementation Process (was Designing the Implementation Process)
 - 4.5.2 Hardware Manufacturing Process
 - 4.5.3 Software Implementing Process

- 4.5.4 Hardware Software Integration
- 4.5.5 Test, Verification, Validation, and Certification
- 4.5.6 Implementation Management

4.6 OPERATING [c]

- 4.6.1 **Designing and Optimizing Sustainable and Safe Operations (was Designing and Optimizing Operations)**
- 4.6.2 Training and Operations
- 4.6.3 Supporting the System Lifecycle
- 4.6.4 System Improvement and Evolution
- 4.6.5 Disposal and Life-End Issues
- 4.6.6 Operations Management

4.7 LEADING ENGINEERING ENDEAVORS [in CDIO+EL Syllabus]

Engineering Leadership builds on factors already included above, including:

- **Core Personal Values and Character of Leadership** including topics in Attitudes, Thought and Learning (2.4), and in Ethics, Responsibility, Equity, and Core Personal Values (2.5)
- **Relating to Others**, including topics in Communications (3.2) Teamwork (3.1), and potentially Communications in a Foreign Language (3.3)
- **Making Sense of Context**, including topics in External, Societal and Natural Context (4.1); Enterprise and Business Context (4.2) and System Thinking (2.3)

In addition there are several topics that constitute creating a **Purposeful Vision**:

- 4.7.1 Thinking Creatively and Imagining Possibilities (which builds on and expands Creative Thinking 2.4.3)
- 4.7.2 Defining the Solution (which builds on and expands Understanding Needs and Setting Goals 4.3.1)
- 4.7.3 Creating New Solution Concepts (which builds on and expands 4.3.2 and 4.3.3)

And several topics that lead to **Realizing the Vision**:

- 4.7.4 Building and Leading and Organization and Extended Organization (which builds on 4.2.4)
- 4.7.5 Planning and Managing a Project to Completion (which builds on 4.3.4)
- 4.7.6 Exercising Project/Solution Judgment
- 4.7.7 Innovation – the conception, design and introduction of new goods and services (which builds on 4.4)
- 4.7.8 Invention – the development of new devices, materials or processes that enable new goods and services
- 4.7.9 Implementation and Operation – the creation and operation of the goods and services that will deliver value (which are the leadership of 4.5 and 4.6)

These last three items are in fact the leadership of the core processes of engineering: conceiving, designing, implementing and operating

4.8 ENGINEERING ENTREPRENEURSHIP [in CDIO+EL Syllabus]

Engineering Entrepreneurship includes by reference all of the aspects of Societal and Enterprise Context (4.1 and 4.2), all of the skills of Conceiving, Designing, Implementing and Operating (4.3 – 4.6) and all of the elements of Engineering Leadership (4.7). In addition, there are the Entrepreneurship specific skills:

- 4.8.1 Company Founding, Formulation and Organization
- 4.8.2 Business Plan Development
- 4.8.3 Company Capitalization and Finances
- 4.8.4 Innovative Product Marketing
- 4.8.5 Conceiving products and services around new technologies
- 4.8.6 The Innovation System, Networks, Infrastructure and Services
- 4.8.7 Building the Team and Initiating Engineering Processes (conceiving, designing, implementing and operating)
- 4.8.8 Managing Intellectual Property