PROPOSED CURRICULUM FOR A MASTER OF SCIENCE
DEGREE IN COST ENGINEERING
TCM Framework: General Reference

INTRODUCTION

This educational practice represents a proposed curriculum for a master of science degree program with an emphasis on cost engineering. The purpose of this document is to support post-graduate education in cost engineering, by providing the following:

• Guidance to faculty and students in the formulation of master’s degree programs that will concentrate on cost engineering, while maximizing the opportunity for cross-disciplinary coursework.
• A basis for course selection or self-study where no such degree program exists.

The curriculum for this course of study is based upon the content of The Total Cost Management (TCM) Framework, and AACE recommended practice 11R-88, Required Skills and Knowledge of Cost Engineering. It also references coursework that is typical in Construction, Project, and Engineering Management degree programs.

A master’s-level curriculum in cost engineering should specify prerequisite undergraduate courses, as identified in this EP. The institution may allow professional experience to serve as a substitute for formal coursework, or supplementary coursework to be undertaken concurrently with the master’s-level curriculum. This proposed curriculum provides course descriptions and outlines components of each subject.

The proposed curriculum focuses on cost engineering, and is in alignment with project Engineering, Procurement, Construction, and Management (EPCM), as well as Manufacturing and Information Technology. This recommended program of study offers a logical progression in formal education. Most bachelor’s degree and master’s degree Construction, Project, and Engineering programs offer, as a part of their scope a study, a brief overview of project controls. In many cases these programs are accredited in North America and internationally by the American Council for Construction Educators (ACCE).

The objective of this EP is to present to Universities that already offer higher education in Construction, Project, or Engineering Management a proposed degree program that is in line with industry and offers more extensive and deep coursework in project controls, cost engineering, and quantity surveying.

PROPOSED CURRICULUM

A. Undergraduate Prerequisite Subjects

• Engineering or Business Economics
• Financial or Project Accounting
• Business Writing
• Mathematics

Preferably, the incoming student will have an undergraduate degree in engineering, business, finance, or mathematics, with a minimum GPA of 3.0.
B. Cost Engineering Required / Core Courses
(8 courses / 24 credits from this list)

- Cost Estimating
- Planning and Scheduling
- Procurement and Contracting
- Project and Contract Administration
- Fundamentals of Project Management
- Project Controls Ethics
- Decision and Risk Analysis
- Performance Measurement and Data Analytics

C. Cost Engineering Elective Subjects
(3 courses / 9 credits from this list)

- Advanced Economic Analysis
- Appraisal and Valuation
- Communications in Technical Organizations
- Organizational Theory
- Contract and Commercial Law
- Project Finance
- Special Topics in Cost Engineering

D. General Electives

- Interdisciplinary subjects as approved by the University to support the degree program or dual degree
  - Engineering
  - Construction Management
  - Manufacturing
  - Real Estate
  - Project Management
  - Engineering Management
  - Information Systems
  - Law
  - Finance
  - Business

E. Capstone Project (3 credits)

- Thesis on a cost engineering subject
COURSE CONTENT

A. Undergraduate Prerequisite Subjects

Preferably, the incoming student will have an undergraduate degree in engineering, business, finance, or mathematics, with a minimum GPA of 3.0. An incoming candidate for a master's program who does not have college credit for any of these subjects should either add them to his/her total degree program or demonstrate proficiency in them to the satisfaction of the university. The institution may allow professional experience or certification to serve as a substitute for formal course work.

1. Engineering or Business Economics
   a. Fundamentals of economics, including:
      i. Micro- and macro- economics
      ii. Demand and supply
      iii. Price determination
      iv. Market structures
      v. Labor markets and wages

2. Financial or Project Accounting
   a. Basic financial accounting, including:
      i. Bookkeeping
      ii. Debit and credit
      iii. Depreciation
      iv. Ledgers
      v. Generally Accepted Accounting Principles
      vi. Cash and accrual basis
      vii. Financial reports

3. Business Writing
   a. Demonstrated competency in written communication gained through prior formal instruction or experience

4. Mathematics
   a. Demonstrated competency in mathematics, including:
      i. Analytical geometry
      ii. Algebra
      iii. Calculus
      iv. Basic probability and statistics
B. Cost Engineering Required Subjects.

Subjects in this category are intended to provide a basic background in business or project management and are considered essential for the professional cost engineer. 8 courses / 24 credits of the degree program will be devoted to pursuing these subjects.

1. Cost Estimating
   a. The equivalent of a 3-credit course built around construction or manufacturing cost estimating which provides an introduction to definitive estimating. It should include these subjects:
      i. Types of estimates, techniques, and accuracy
      ii. Cost data sources
      iii. Interpreting drawings and specifications
      iv. Labor costs
      v. Materials costs
      vi. Equipment costs
      vii. Overhead, indirect, and distributable costs
      viii. Basic contingency
      ix. Inflation/Escalation
      x. Cost indices
      xi. Profit
      xii. Introduction to cost estimating software
      xiii. Practical exercise in pricing a project or product
      xiv. Proposals
      xv. Contractual, managerial, and legal aspects of estimating and budgeting

2. Planning and Scheduling
   a. The equivalent of 3-credit course designed to provide basic proficiency in common scheduling techniques and theory. These subjects should be included:
      i. History of scheduling
      ii. Resource planning
      iii. Bar chart (Gantt) scheduling
      iv. CPM Scheduling
      v. Time-scaled networks
      vi. Linear Scheduling
      vii. Schedule baselines
      viii. Contractual, managerial, and legal aspects of scheduling
      ix. Schedule delay
      x. Introduction to Planning and Scheduling Software

3. Procurement and Contracting
   a. This is a detailed study of standard (AIA, AGC, U.S. Government, FIDIC etc.) and selected user-prepared contract forms. Topics include:
      i. Procurement strategies and delivery methods
      ii. Value for money analysis
      iii. Contract forms
      iv. Purchase orders
      v. Consulting contracts
      vi. Liabilities and risk allocation
      vii. General conditions
      viii. Special or supplementary conditions
      ix. General requirements
4. Project and Contract Administration
   a. This subject area provides an understanding of the administration of contracts and purchase orders. Topics include:
      i. Contractor and vendor qualification
      ii. Procurement strategies and delivery methods
      iii. Proposals
      iv. Bidding and evaluation
      v. Payment
      vi. Financial management
      vii. Change processing
      viii. Document control
      ix. Claims and disputes
      x. Contract closeout
      xi. Legal principles
      xii. Ethics principles

5. Fundamentals of Project Management
   a. This course provides a systematic look at project planning, by defining essential elements. Topics in this group apply the principles learned in earlier coursework. Topics include:
      i. Project stakeholders and interests
      ii. Organizational structures for project management
      iii. Insurance and bonding
      iv. Budget
      v. Work breakdown structures and charts of accounts
      vi. Project management plans
      vii. Project initiation
      viii. Subcontracting
      ix. Document control
      x. Change control
      xi. Contingency management
      xii. Project handover
      xiii. Historical data files
      xiv. Project closeout
      xv. Introduction to project management software

6. Project Controls Ethics
   a. This course introduces students to ethical methodologies, principles, values, and frameworks, then uses that foundation to study discipline- and field-specific codes of ethics within the profession. The course explores the ethical responsibilities of project management professionals to themselves, corporations, the government, and the public.
      i. Human nature
      ii. Ethics concepts
      iii. Codes of ethics
      iv. Compliance
      v. Interdependencies
vi. Intelligent disobedience
vii. Culture and values
viii. Integrity
ix. Legal concepts

7. Decision and Risk Analysis
   a. This course includes a review of the basic components of risk: the probability of an event and the consequences of the event. The core elements of probability theory are reviewed, and applied to the basic components of estimating and scheduling theory. Risk management is assessed from its basic steps: risk identification, risk impact analysis, risk response planning, risk monitoring and control, and recovery. Topics include:
      i. Probability
      ii. Descriptive statistics
      iii. Sampling theory
      iv. Hypothesis testing
      v. Decision theory
      vi. Correlation and regression
      vii. Types of risk
      viii. Risk tolerance
      ix. Risk modeling, using Monte Carlo simulation
      x. Risk management
      xi. Insurance
      xii. Risk transfer
      xiii. Introduction to risk modeling software

8. Performance Measurement and Data Analytics
   a. This course is designed to demonstrate and apply principles of economic analysis to a variety of business situations and case studies. Typical of included subjects are:
      i. Data collection and sampling
      ii. Audit techniques
      iii. Variance analysis
      iv. Earned value analysis
      v. Value engineering
      vi. Forecasting and trending
      vii. Project evaluation
      viii. Project monitoring
      ix. Key performance indicators
      x. Reporting, graphs, and charts

C. Cost Engineering Elective Subjects

Students will select a minimum of 3 courses / 9 credits from this group of subjects.

1. Advanced Economic Analysis
   a. This course is designed to demonstrate and apply principles of economic analysis and finance in a variety of business situations and case studies. Topics include:
      i. Life-cycle cost analysis
      ii. Time value of money
      iii. Evaluation of purchase, lease, and rental options
      iv. Profitability studies
      v. Cost-Benefit studies
vi. Budgeting and cash flow analysis
vii. Inflation/Escalation
viii. Time value of money
ix. Equivalence
x. Methods for comparison of economic alternatives
xi. Break-even analysis

2. Appraisal and Valuation
   a. This course aims to establish the economic context for the creation of value, introduce the principles for the assessment of value in property and product markets, develop a clear understanding of the valuation process and appropriately apply the principal valuation methods to a range of property / product types and interests. Topics include:
   i. Basic economics and structure of markets
   ii. Legal rights
   iii. Investment characteristics
   iv. Principles of valuation
   v. Ethical considerations
   vi. Price, value, and worth
   vii. Data sources

3. Communications in Technical Organizations
   a. This course teaches students essential communication skills utilized by successful managers in technical organizations, including subjects such as:
   i. Types of communication
   ii. Conveying a brand and culture
   iii. Audiences and stakeholders
   iv. Personality traits
   v. Presentations
   vi. Proposal writing
   vii. Meeting management
   viii. Social media
   ix. Cultural challenges

4. Organizational Theory
   a. This subject area deals with practical applications of the organization including management theories, organizational principles, and processes of organizational behavior. Topics include:
   i. Management concepts
   ii. Leadership/management styles
   iii. Personnel management
   iv. Organizational management
   v. Conflict management
   vi. The project office
   vii. Strategy and objectives
   viii. Global projects

5. Contract and Commercial Law
   a. This overview of the body of law is included to equip students with the skills to formulate and implement strategies and policies to minimize potential legal pitfalls. Topics include:
   i. General principles of tort and contract law
   ii. Contracts and terms
   iii. Contract negotiations
iv. Insurance and bonding  
v. Liability / negligence  
vi. Breach and damages  
vii. Intellectual property rights  
viii. Licensing and technology transfer  
ix. Confidential and proprietary business information  
x. Constructive changes  
xi. Defective work  
xii. Warranties  
ixii. Termination  
ixiv. Bankruptcies  
ixv. Claims  
ixvi. Alternative dispute procedures  

6. Project Finance  
a. This course teaches students to understand finance in the context of project organizations.  
i. Funding sources  
ii. Financial markets, stocks, and portfolios  
iii. Entrepreneurial finance  
iv. Corporate finance  
v. Personal finance  
vi. Corporate financial statements  
vii. Organizational finance theory  
viii. Debt and equity financing  
ix. Crowdfunding  

7. Special Topics in Cost Engineering  
a. Universities normally have a “Special Topics” course category which enables a student to pursue one or more credits of study in a subject area agreed to between the student and the advisor. Those involving a cost engineering topic may be credited to the electives group.  

D. Capstone Project (3 credits)  

1. The Capstone Project is to be completed in the final term of the masters program, and provides an opportunity for students to apply what they have learned by producing a substantial piece of research under the tutelage of an industry advisor and program faculty. The project is expected to be aligned with students’ chosen areas of interest. The project product will be a thesis or graduate report on a cost engineering subject.  

E. General Electives  

1. Other elective courses may draw from those offered in Masters of Business Administration (MBA), Masters of Engineering Management, or Master of Science in Project Management degree programs, with an emphasis on project-related industry specifics and applications. Interdisciplinary subjects are acceptable as approved by the University to support the degree program or dual degree.  
a. Engineering  
b. Construction Management  
c. Manufacturing  
d. Real Estate  
e. Project Management  
f. Engineering Management
REFERENCES


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