

DEPARTMENT OF CONSTRUCTION ENGINEERING & MANAGEMENT

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The graduate programs in Construction Engineering & Management (CEM) department has been established at KFUPM since 1984. The objective of the CEM programs is to provide an in-depth coverage of all the established disciplines of construction engineering and management such as engineering management, construction organization and contracts, project management and control, construction methods, cost engineering, etc. It is designed to prepare fresh engineering graduates for professional careers and to enhance the knowledge and skills of those already practicing the discipline. In the CEM programs, the theoretical aspects of the discipline are interwoven with the practical ones so as to provide the synergy necessary for the student to have the option of pursuing an academic and/or professional career in the industry.

The Construction Engineering & Management Department offers three graduate programs:

- Master of Science in Construction Engineering & Management,
- Master of Engineering in Construction Engineering & Management,
- Master of Engineering Management.

The Master of Science in CEM option requires the student to complete 30 credit hours, while the Master of Engineering in CEM and Master of Engineering Management option requires 33 credit hours. The Master of Engineering in CEM and engineering management is not available to research or graduate assistants. The Master of Engineering Management program is designed to satisfy the local and global needs of the industry. The program is an interdisciplinary and offers students a wide selection of courses from the Construction Engineering & Management Department, Systems Engineering Department, KFUPM business school as well as selected courses from other departments.

Admission Requirements

Admission to either program requires fulfilling all requirements of the Deanship of Graduate Studies. In addition, the applicant should meet the following CEM requirements:

- Bachelor's degree in Engineering or equivalent to KFUPM Bachelor's degree with GPA > 2.5.
- Applicants may have to take extra courses to cover areas of deficiency without graduate credit, if needed.

**MASTER OF SCIENCE
IN CONSTRUCTION ENGINEERING & MANAGEMENT**

Degree Requirements

(a) Core Courses (21 credit hours)		Credit Hours	
Project Planning and Scheduling	CEM 510	3	
Construction Estimating	CEM 511	3	
Construction Contracting and Administration	CEM 520	3	
Construction Engineering	CEM 530	3	
Statistical Analysis in Planning	CRP 505	3	
Research Seminar	CEM 599	0	
Thesis	CEM 610	6	
(b) Elective Courses (9 credit hours)			
Two CEM Courses	CEM 5xx	6	
One Technical Elective Course	XXX 5xx	3	

Degree Plan

Full Time

COURSE	TITLE	LT	LB	CR	COURSE	TITLE	LT	LB	CR
First Year									
CEM 510	Project Planning and Scheduling	3	0	3	CEM 511	Construction Estimating	3	0	3
CEM 520	Construction Contracting & Administration	3	0	3	CEM 5xx	CEM Elective II	3	0	3
CEM 5xx	CEM Elective I	3	0	3	CRP 505	Statistical Analysis in Planning	3	0	3
		9	0	9			9	0	9
Second Year									
CEM 530	Construction Engineering	3	0	3	CEM 610	Thesis	0	0	6
XXX 5xx	Elective	3	0	3					
CEM 599	Research Seminar	1	0	0					
CEM 610	Thesis	0	0	IP					
		7	0	6			0	0	6
Total credit hours required in Degree Program : 30									

- Students could take OM 502 Statistical Analysis for Business in lieu of CRP 505.
- The order of taking the courses can be different from above but students must take the core courses before electives.

**MASTER OF ENGINEERING
IN CONSTRUCTION ENGINEERING & MANAGEMENT**

Degree Requirements

(a) Core Courses (21 credit hours)		Credit Hours
Project Planning and Scheduling	CEM 510	3
Construction Estimating	CEM 511	3
Construction Contracting and Administration	CEM 520	3
Construction Engineering	CEM 530	3
Construction Project Management	CEM 540	3
Statistical Analysis in Planning	CRP 505	3
Research Seminar	CEM 599	0
Master of Engineering Report	CEM 600	3

(b) Elective Courses (12 credit hours)		
Three CEM Courses	CEM 5xx	9
One Technical Elective Course	XXX 5xx	3

Degree Plan

Part Time

COURSE	TITLE	LT	LB	CR	COURSE	TITLE	LT	LB	CR
First Year									
CEM 510	Project Planning and Scheduling	3	0	3	CEM 511	Construction Estimating	3	0	3
CEM 520	Construction Contracting & Administration	3	0	3	CRP 505	Statistical Analysis in Planning	3	0	3
		6	0	6			6	0	6
Second Year									
CEM 530	Construction Engineering	3	0	3	CEM 5xx	CEM Elective II	3	0	3
CEM 5xx	CEM Elective I	3	0	3	CEM 5xx	CEM Elective III	3	0	3
		6	0	6			6	0	6
Third Year									
CEM 540	Construction Project Management	3	0	3	CEM 600	Master of Engineering Report	0	0	3
CEM 599	Research Seminar	1	0	0					
XXX 5xx	Elective	3	0	3					
		7	0	6			0	0	3
Total credit hours required in Degree Program : 33									

- Students could take OM 502 Statistical Analysis for Business in lieu of CRP 505.
- The order of taking the courses can be different from above but students must take the core courses before electives.

MASTER OF ENGINEERING MANAGEMENT

Degree Requirements

(a) Core Courses (27 credit hours)	Credit Hours
Statistical Analysis in Planning	CRP 505 3
Financial Reporting and Analysis	ACCT 509 3
Leadership and Organizational Behavior/Organizational Theory & Design	MGT 512 or MGT 511 3
Advanced Engineering Economics	EM 510 3
Quality Management / Project Quality Management	EM 515 or CEM 515 3
Quantitative Methods in Engineering Management	EM 520 3
Decision Analysis	EM 530 3
Engineering Project Management	EM 550 3
Research Seminar	EM 599 0
Master of Engineering Report	EM 600 3

(b) Elective Courses (6 credit hours)	Credit Hours
Elective I	EM/CEM/ISE/MGT/MKT/ACCT/FIN/ECON/OM/MIS/MBA 5xx 3
Elective II	EM/CEM/ISE/MGT/MKT/ACCT/FIN/ECON/OM/MIS/MBA 5xx 3 Elective II can also be a relevant graduate course taken from the College of Engineering or the College of Petroleum Engineering and Geosciences with the consent of graduate advisor.

Degree Plan

COURSE	TITLE	LT	LB	CR	COURSE	TITLE	LT	LB	CR
First Year									
CRP 505	Statistical Analysis in Planning	3	0	3	EM 520	Quantitative Methods in EM	3	0	3
EM 515	Quality Management*	3	0	0	ACCT 509	Financial Reporting and Analysis	3	0	3
EM 510	Advanced Engineering Economics	3	0	3					
		9	0	9			6	0	6
Second Year									
MGT xxx	MGT 512 or MGT 511	3	0	3	EM 599	Research Seminar	1	0	0
EM 530	Decision analysis	3	0	3	EM 550	Engineering Project Management	3	0	3
					XXX xxx	Elective I	3	0	3
		6	0	6			7	0	6
Third Year									
EM 600	Master of Engineering Report	0	0	3					
XXX xxx	Elective II	3	0	3					
		3	0	6					
Total credit hours required in Degree Program : 33									

* Students can take CEM 515 in lieu of EM 515.

CONSTRUCTION ENGINEERING & MANAGEMENT

CEM 510 Project Planning and Scheduling (3-0-3)

Planning, scheduling, and control of construction projects using Critical Path Method (CPM) and Project Evaluation and Review Technique (PERT); Resource leveling; Scheduling with limited resources; Time-cost tradeoffs, Introduction to complex networks, Short interval production scheduling, and related Computer applications.

Prerequisite: Graduating Standing

CEM 511 Construction Estimating (3-0-3)

Introduction to cost estimating of construction, types of cost estimating for construction projects, the estimating process, measuring quantity of construction works pricing construction works, pricing subcontractor works and general expenses, computer application for cost estimating, budget and elemental estimating, value analysis and lifestyle costing, recent development in construction cost estimating.

Prerequisite: Graduating Standing

CEM 512 Value Engineering (3-0-3)

Value engineering concepts, function analysis system techniques (FAST), diagramming, creativity, matrix evaluation, design-to-cost, life cycle costing, Preliminary estimating methods, human relations and strategies for organizing, performing and implementing value engineering; Sustainability; Constructibility; Computer Applications.

Prerequisite: Graduating Standing

CEM 513 Construction Productivity (3-0-3)

Components of the construction productivity system; measurements of productivity: Work sampling, Craftsman's Questionnaire, Foreman Delay Survey, and related techniques. Construction methods improvement: Crew Balance, Chart, Flow Diagram and Process Chart, Quality Circles; safety workers' motivation and productivity improvement programs. Application of above techniques on real construction projects.

Prerequisite: Graduating Standing

CEM 514 Modeling Construction Operations (3-0-3)

Model Development for construction operations at project site and the contractor organization level. The application of analytical techniques in construction management. Topics include linear programming, transportation model, assignment model, queuing theory, Inventory management, Monte Carlo Simulation and other applicable optimization Techniques.

Note: Can not to be taken for credit with EM 520 or ARE 511.

Prerequisite: Graduating Standing

CEM 515 Project Quality Management (3-0-3)

Quality knowledge and Quality improvement methods, Quality standards, Quality needs and overall strategic plans, customer satisfaction and focus, tools for Quality Project Management, Statistical process control, tools for continuous improvement, recent developments in Quality in Constructed projects, ISO standards, survey of computer application software related to quality management.

Prerequisite: Graduating Standing

CEM 516 Project Risk Management (3-0-3)

Putting risk into perspective, risk and uncertainty, risk management system, decision theory, game theory, utility and risk attitude, multicriteria decision making models, simulation, risks and the construction project – money, time and technical risks, contracts and risks, Vulnerability, Computer applications.

Note: Can not to be taken for credit with EM 530.

Prerequisite: CRP 505 or equivalent, CEM 510, CEM 520

CEM 517 Project Safety Management (3-0-3)

Safety management in Construction Projects, Importance of safety management to effective Construction Management. The course gives specific recommendations to overall improvement of construction safety and outlines steps to reduce accidents in construction site. Students are also exposed to the available safety softwares and other computer applications.

Prerequisite: Graduating Standing

CEM 518 Project Cost Management (3-0-3)

Application of scientific principles and techniques to the problems of cost planning and cost control. Issues in cost management including evaluating investment alternatives, life cycle costing, cost analysis methods, cost control, and computer applications.

Note: Can not to be taken for credit with EM 510 or ARE 512.

Prerequisite: CEM 511

CEM 519 Sustainable Constructions (3-0-3)

Techniques and methods of sustainable construction. Integration of collaborative team effort from owners, architects, engineers, constructors, and consultants. Influences on the cost and schedule due to a sustainable construction project. LEED assessment process high performance building and green building materials, economical analysis of green building.

Prerequisite: Graduating Standing

CEM 520 Construction Contracting and Administration (3-0-3)

Basic characteristics of the construction industry; interrelationship of the design and construction processes, construction contract documents, bidding and awarding procedures, construction claims and disputes, national labor and procurement regulations, leadership.

Prerequisite: Graduating Standing

CEM 522 Globalization and Construction Industry (3-0-3)

The course will expose the students to the differences in Construction systems, technology, management and culture among the advanced industrial countries, newly industrialized countries and local construction industry. Globalization movement and its effect on construction industry and local design and construction firms. Special aspects of International projects including investigation, planning, procurement, logistics, personnel and financing.

Prerequisite: Graduating Standing

CEM 525 Project Delivery Systems (3-0-3)

The historical evolution of project delivery, the roles of procurement and contracting methods in project success, strengths and weaknesses of contemporary delivery system. Emphasis will be placed on new trends in the Project Delivery Systems such as Construction Management (CM), Design-Build (DB), Build Operate and Transfer (BOT), Build Own,

Operate and Transfer (BOOT), etc.: when to use, process variations, procurement, contracts and contracts language, performance specification, roles of parties, organization and management, conceptual estimating; Lean construction; Computer applications.

Prerequisite: CEM 520

CEM 527 Construction Claims and Dispute Resolution (3-0-3)

Construction claims, Causes and types of construction claims, construction disputes, causes and types of construction disputes, disputes avoidance techniques, problems of traditional dispute resolution techniques, alternative dispute resolution techniques – Arbitration, mediation, conciliation, dispute review boards, mini trials, Ethics in the Construction Industry, Computer applications.

Prerequisite: Graduating Standing

CEM 530 Construction Engineering (3-0-3)

Introduction to Construction Industry; construction projects; and the study of construction; types of construction works; Earthworks, Drilling, Lifting and Piling; Construction Equipment; Types of Equipment, Production Estimates, Selection of Equipment, Equipment Economic; Concrete Work and Forming System; Planning for Construction.

Prerequisite: Graduating Standing

CEM 531 Industrial Construction (3-0-3)

Project Life Cycle for building Heavy Industrial Construction Facilities, power plants, chemical plants, oil refineries. Best practices for each stage in the project life cycle as per the Construction Industry Institute. Topics include: Job planning and organization including Pre Project Planning, Planning for Startup, Prefabrication Preassembly Modularization and Offsite Fabrication, knowledge management, Risk Management for Industrial Projects.

Prerequisite: Graduating Standing

CEM 532 Design and Construction of Temporary Support Structures (3-0-3)

Planning and field engineering for temporary support structures. Design and Construction of concrete formwork, cofferdams, scaffolding, dewatering systems, and other temporary structures required by construction operations, Computer applications.

Prerequisite: Graduating Standing

CEM 533 Intro to Construction of Harbor, Coastal and Ocean Structures (3-0-3)

Construction methods and equipment for construction of cofferdams, caissons, wharves, marine terminal, outfall sewers, power plants intakes and discharge, sub marine oil and gas pipelines, dredging, offshore platform, ocean structures, sub-sea and deep ocean facilities, case studies.

Prerequisite: CEM 530

CEM 540 Construction Project Management (3-0-3)

An integrative perspective to Construction Project Management to tie together knowledge areas of Project Management that have been individually covered under various courses such as Planning and Scheduling, Cost Estimating, Quality Management, Human Resources Management and Risk Management. Other areas to be covered include Project procurement management, Project communication management, and Computer applications.

Note: Can not to be taken for credit with EM 550.

Prerequisite: CEM 510, CEM 511, CEM 520

CEM 542 Technology and Innovation in Constructions and Project Management (3-0-3)

Technology concepts; terminology and classifications. Construction advanced technologies and construction applications. Technology management in construction: R&D; technological innovation; technology deployment; support techniques, Construction technology in Saudi Arabia; innovative behavior; strategy; policy; support system; university/industry interaction, sustainability, lean construction, Research projects for industry applications.

Prerequisite: Graduate Standing

CEM 547 Construction Management with Building Information Modeling (3-0-3)

Fundamentals and practical use of information technologies in the construction industry; basic concepts of building information modeling (BIM); review of software and technology available for BIM; practical use of BIM including design and clash detection; impact of BIM on construction management functions; construction scheduling and sequencing using BIM; cost estimating using BIM; facility management with BIM; integrated approach to navigate BIM as a multi-disciplinary design, analysis, construction, and facility management technology; class exercise to create a BIM model and to use it in scheduling, sequencing, cost estimating, management, and simulation of a construction project.

Prerequisite: CEM 510, CEM 511

CEM 549 Computer Applications in Construction Engineering and Management (3-0-3)

Use of the state of the practice applications for management of construction projects. Industry standard applications for planning and scheduling, cost estimation, 3D/4D planning, process improvement, Decision and Risk Analysis. Students work on a number of intensive construction problems.

Prerequisite: CEM 510, CEM 511

CEM 590 Special Topics in Construction Engineering and Management (3-0-3)

Advanced topics selected from the major areas of Construction Engineering and Management to provide the student with recent developments.

Prerequisite: Graduate Standing

CEM 599 Research Seminar (1-0-0)

Introduction to the principles of scientific research: The research question, hypotheses, constructs and their operationalization, research design, internal and external validities of research findings, measurements and their reliability, data collection techniques, professional ethics; basic elements of the research proposal. Grades are pass or fail.

Prerequisite: Graduate Standing

CEM 600 Master of Engineering Report (0-0-3)

A report on an independent study performed under the supervision of a CEM faculty advisor. This report should include an introduction to the topic, literature review, research methodology, analysis of data, conclusions and recommendations, appendixes and references. The report will be presented and orally examined by a faculty committee.

Prerequisite: CEM 599

CEM 606 Independent Research (3-0-3)

This course is intended to allow the student to conduct research in advanced problems in his M.S .research area. The student taking the course should submit a research plan to be approved by his instructor . The student is expected to deliver a seminar and submit a report on his research outcomes at the end of the course. Graded on a Pass or Fail basis.

Corequisite: CEM 599

Prerequisite: Prior arrangement with an instructor

CEM 610 Thesis (0-0-6)

The student has to undertake and complete a research topic under the supervision of a graduate faculty member in order to probe in-depth a specific problem in Construction Engineering and Management.

Corequisite: CEM 599

ENGINEERING MANAGEMENT

EM 510 Advanced Engineering Economics (3-0-3)

Monetary interest computations principles and methods. It also studies the effect of inflation, depreciation and taxes, cost accounting and estimation, risk, uncertainty and sensitivity analysis, capital budgeting, advanced asset replacement analysis. Advanced topics in engineering economics include: overcome multiple IRR solutions difficulty for non-simple cash flows, real options analysis and cash flow transform techniques. The use of computers spreadsheets is emphasized through periodic assignments and real life case studies.

Note: Can not be taken for credit with CEM 518

Prerequisite: Graduate Standing

EM 515 Quality Management (3-0-3)

Quality management principles and history, total quality management, quality control, quality improvement, assurance and reliability in design and production. Quality engineering tools are also emphasized including: experimental engineering design and analysis, measurement system analysis in engineering, engineering process modelling, product and process optimization in engineering, engineering regression, response surface methodology in engineering, robust engineering parameter design, Six Sigma methods, and exploration of methods of building and sustaining quality organizations.

Note: Equivalent to CEM 515

Prerequisite: Graduate Standing

EM 520 Quantitative Methods in Engineering Management (3-0-3)

Linear Programming: Concepts and Solution Techniques, Transportation and Assignment Models, Goal Programming Model, Inventory Management Models, Queuing Theory, Event based Simulation, and Markov chains. Computer applications including spreadsheets and programming tools are also presented through real life case studies.

Prerequisite: Graduate Standing

EM 530 Decision Analysis (3-0-3)

Covers the theory and practice of decision analysis and risk assessment. Covers decision theory, game theory, utility and risk attitude, probability assessment, multi-criterion decision making models, Value of information in decision making, decision trees and influence diagrams, building decision support systems, and Monte Carlo Simulation technique. Describes practical applications through real-world engineering /project management decision analysis applications. Computer applications.

Prerequisite: CRP 505

EM 550 Engineering Project Management (3-0-3)

Project management framework, strategic management and project selection, project organization, human aspects of project management, conflicts and negotiations, scope management, time management, cost management, risk management, contracts and procurement, project termination, the project management office, and modern developments in project management, including: PMI, PRINCE 2, and ISO 21500. Integrates and clarifies the principles and tools through case studies from a variety of disciplines.

Note: Can not be taken for credit with CEM 540

Prerequisite: Graduate Standing

EM 560 Manufacturing System and Supply Chain Design (3-0-3)

Manufacturing planning and control systems, Just in Time (JIT), JIT II, Capacity Planning, Production Activity Control, Independent demand inventory management, vendor management inventory (VMI), bullwhip effect, MRP and MRP II, Distribution Requirement planning, MPC frontiers (MPC system schematic, beyond the schematic, Optimized production technology (OPT), MPC for process industries), ERP manufacturing systems. The manufacturing strategies: Lean, Agile and virtual manufacturing.

Prerequisite: Graduate Standing

EM 570 Maintenance and reliability Systems (3-0-3)

This course examines the effect of different maintenance strategies such as scheduled maintenance, preventive maintenance, and Reliability centered maintenance (RCM), and RBI. It assess maintainability measures and system availability indicators, Total Productive Maintenance (TPM), reliability improvement tools: fault trees, failure mode and effect analysis and root cause analysis.

Prerequisite: Graduate Standing

EM 571 Health Care Management (3-0-3)

This course include the management and improvement of health care systems. The course will orient the students about health care systems components: Queuing theory applications in the Health care, Health care delivery systems, process quality and statistical models, human factors and patient systems, clinical process improvement, process workflow and staff scheduling.

Corequisite: EM 520

EM 572 Safety and loss prevention Engineering (3-0-3)

This course is an introduction to the principles of safety engineering applied to industrial situations. Job safety analysis, reduction of accident rates, protective equipment, safety rules and regulations, environmental hazards, health hazards, and ergonomic hazards are covered. Safety and loss prevention. Major process hazards. Hazard identification, assessment and prevention. Personal safety in industrial environment. Fire explosion and toxic release. Safety systems.

Prerequisite: Graduate Standing

EM 590 Special Topics in Engineering Management (3-0-3)

Advanced topics are selected from the major areas of Engineering Management to provide the student with recent developments.

Prerequisite: Graduate Standing

EM 599 Research Seminar (1-0-0)

This course is designed to give the student an overview of research in the engineering management specialty and in the department, familiarity with the research methodology, journals and professional societies in the discipline. Graded on a Pass or Fail basis.

Prerequisite: Graduate Standing

EM 600 Master of Engineering Report (0-0-3)

Research study that deals with analysis and/or design of significant problem or case study related to the field of Engineering Management prepared under the supervision of an Engineering Management faculty. The project report should follow formal report format including introduction, literature review, research methodology, collection and analysis of

data, conclusions and recommendations, list of references and appendices of important information.

Corequisite: EM 599