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MEP Systems Course Content and Delivery in Construction Curricula

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ABSTRACT

The Mechanical, Electrical, and Plumbing (MEP) systems topic is a required content in construction higher education programs. The accreditation agencies incorporate MEP concepts into their required student learning objectives, emphasizing the subject's importance in professional practice. However, the extensive list of topics, along with changes in technology and components, makes it challenging to teach this subject effectively. There are different approaches to delivering MEP systems content in a construction curriculum, including required or elective stand-alone courses, integrating the concepts into another construction course, or requiring a non-construction/design course from another discipline. This paper reviews the MEP systems course requirements of construction programs in Texas. As part of this study, the catalog requirements of the construction degree programs are queried for the delivery of MEP content. The data is presented using rubrics and numbering system designations, highlighting patterns and trends. A discussion of the differences among the construction science, management, and technology degree designations is included to highlight the variances in accreditation and structural organization.

INTRODUCTION AND BACKGROUND

The Mechanical, Electrical, and Plumbing (MEP) systems are critical components of construction projects, accounting for a large share of buildings' construction and operating costs. A typical MEP course is expected to cover multiple systems and to take a multidisciplinary approach to address the extensive list of possible topics. The rapid development and adaptation of new technologies and systems add to this complexity.

The accreditation agencies incorporate MEP concepts into their required student learning objectives, emphasizing the subject's importance in professional practice. For example, the American Council for Construction Education (ACCE) addresses the MEP content with a required learning outcome: “SLO 17 - Understand the basic principles of HVAC, electrical and plumbing systems” [1]. ABET (applied and natural science category) criteria for construction management programs address this in broader terms, including multiple components such as systems, technology, and management from pre-design through commissioning [2].

Construction is a multi-disciplinary and application-oriented discipline. The construction higher education programs are often influenced by their development and history, where the programs that originated from architecture or engineering often carry a design-heavy structure, while programs with industrial technology backgrounds include more hands-on applications [3, 4].

It would be fair to say that the MEP courses are among the more challenging construction courses in any curriculum, as they require the delivery of a long list of subjects and system components. There are several examples of MEP course content discussions and educational approaches, some of which emphasize process and management [5-8] where others focus on technology applications [10, 11]. The Associated Schools of Construction hold a faculty bootcamp every year on this subject in collaboration with the Mechanical and Electrical Academic Consortium (MEAC). These bootcamps typically include technical topics such as properties, systems components, construction methods, and estimating for mechanical and electrical systems.

As a starting point, an understanding of the course requirements and content would provide a baseline for this discussion. This paper reviews the MEP systems course requirements of construction programs in Texas. As part of this study, the catalog requirements of the construction degree programs are queried for the delivery of MEP content. The data is presented using rubrics and the common numbering system, highlighting patterns and trends. A discussion of the differences among the construction science, management, and technology degree designations is included to highlight the accreditation and organizational differences.

CLASSIFICATION CODES AND CONSTRUCTION PROGRAM DATA

Texas utilizes the National Center for Education Statistics' Classification of Instructional Programs (CIP) codes [12] to classify programs (identification of the program type) [13] and categorize each course offered by the program [14]. Texas also maintains a database of higher education programs through the Texas Higher Education Coordinating Board (THECB) [13]. The THECB database was searched for the "construction" keyword in "Community Colleges," "State Colleges," "Technical Colleges," "Public Universities," "Independent Colleges and Universities of Texas (ICUT)," "For-Profit Colleges & Universities Authorized by Certificate," and "Other Institutions Authorized by Certificate" categories. Table 1 shows the results of the keyword program search for the bachelor-level [13] .

A total of 21 bachelor-level programs are listed in Table 1. The distribution shows 48% in technology (CIP 15), 33% in engineering (CIP 14), 14% in business (CIP 52), and 5% in construction trades (CIP 46). Table 1 also shows a variety of program names, including "management," "science," "engineering," "engineering technology," or combinations. The "construction management" program title may be linked to technology (CIP 15), engineering (CIP 14), or business (CIP 52) codes, noting the unique nature of construction higher education offerings. Texas Tech University, the University of Texas at Tyler, University of Houston, and University of North Texas list multiple construction degree programs housed under different academic units. Although the program title does not include the word "construction," Texas State University's Concrete Industry Management Program is also included in the search results.

Table 1. Construction Program Inventory at Bachelor Level [13]

INSTITUTION	PROGRAM NAME	CIP CODE (2-DIGIT)
Collin County Community College District	Construction Management	52 – Business
East Texas A&M University	Construction Engineering	14 – Engineering
Lamar University	Construction Management	14 – Engineering
Prairie View A&M University	Construction Science	15 – Technology
Sam Houston State University	Construction Management	15 – Technology
Stephen F. Austin State University	Construction Management	52 – Business
Tarleton State University	Construction Science and Management	15 – Technology
Texas A&M University	Construction Science	15 – Technology
Texas State University	Concrete Industry Management	15 – Technology
Texas State University	Construction Science and Management	15 – Technology
Texas Tech University	Construction Engineering	14 – Engineering
Texas Tech University	Construction Engineering Technology	15 – Technology
The University of Texas at Arlington	Construction Management	14 – Engineering
The University of Texas at El Paso	Construction Engineering and Management	14 – Engineering
The University of Texas at San Antonio	Construction Science and Management	46 – Construction Trades
The University of Texas at Tyler	Construction Engineering	14 – Engineering
The University of Texas at Tyler	Construction Management	52 – Business
University of Houston	Construction Engineering	14 – Engineering
University of Houston	Construction Management	15 – Technology
University of North Texas	Construction Engineering Technology	15 – Technology
University of North Texas	Construction Management	15 – Technology

MECHANICAL, ELECTRICAL, AND PLUMBING (MEP) SYSTEMS COURSE REQUIREMENTS AND OFFERINGS

The latest online academic catalogs are reviewed for each program in Table 1 to identify the MEP systems course requirements associated with the degrees. Table 2 presents the results of the catalog review, including the professional accreditation and degree names. Table 3 includes the course descriptions as noted in the university catalogs. Texas Tech University's Construction Engineering Technology Program is a newly developed (revived) program that does not appear in the university catalog and has no degree or curriculum requirements. Tables 2 and 3 include information for the remaining 20 construction programs.

18 out of 20 (90%) programs require a course with a Mechanical, Electrical, and/or Plumbing (Piping) designation. The Concrete Industry Management Program at Texas State University and the Construction Engineering Technology Program at the University of North Texas do not require courses with MEP designation in the title.

Table 2. MEP Systems Course Requirements for Four-Year Construction Programs

INSTITUTION	PROFESSIONAL ACCREDITATION AND DEGREE NAME	MEP COURSE REQUIREMENT
Collin County Community College District	ACCE Candidate Program - BAS in Construction Management	CNBT 2340 - Mechanical, Plumbing & Electrical Systems in Construction II (Commercial)
East Texas A&M University	ABET Engineering - BS in Construction Engineering	CONE 221 - Building Construction I
Lamar University	ACCE - BS in Construction Management	CMGT 3340 - Industrial and Mechanical Construction CMGT 3350 - Electrical Systems
Prairie View A&M University	ACCE - BS in Construction Science	ARCH 3345 - Environmental Systems
Sam Houston State University	ABET Applied and Natural Science - BS in Construction Management	ETCM 3320 - Mechanical, Electrical & Plumbing (MEP) Systems in Buildings
Stephen F. Austin State University	ACCE Candidate Program - BS Construction Management	CMGT 3117 - Mechanical, Electrical & Piping CMGT 3317 - Mechanical, Electrical & Piping Lab
Tarleton State University	ACCE Candidate Program - BS in Construction Science and Management	CNST 3301 - Building Mechanical and Electrical Systems CNST 3309 - Commercial Construction and Industrial Subsystems
Texas A&M University	ACCE - BS in Construction Science	COSC 325 - Mechanical, Electrical and Plumbing Systems in Construction I
Texas State University	ATMAE – BS in Concrete Industry Management	-
Texas State University	ACCE - BS in Construction Science and Management	CSM 3367 - Mechanical, Electrical and Plumbing Systems
Texas Tech University	ABET Engineering - BS in Construction Engineering	CONE 3302 - MEP Systems and Design for Construction
The University of Texas at Arlington	ABET Applied and Natural Science - BS in Construction Management	CM 3331 - Mechanical & Electrical Systems
The University of Texas at El Paso	ABET Engineering/Applied and Natural Science - BS in Construction Engineering and Management	CE 4354 - Electrical and Mechanical Construction
The University of Texas at San Antonio	ACCE - BS in Construction Science and Management	CSM 4643 - Mechanical, Electrical and Plumbing Systems.
The University of Texas at Tyler	NA (New Program) - BS in Construction Engineering	CMGT 3365 - Mechanical, Electrical and Plumbing Systems
The University of Texas at Tyler	ABET Applied and Natural Science - BS in Construction Management	CMGT 3365 - Mechanical, Electrical and Plumbing Systems
University of Houston	ABET Engineering - BS in Construction Engineering	CNE 4225 - Utility System Construction
University of Houston	ACCE - BS in Construction Management	CNST 2321 - Mechanical and Electrical Systems
University of North Texas	ABET Technology - BSET in Construction Engineering Technology	-
University of North Texas	ACCE - BS in Construction Management	CNET 4630 - Construction Management for Mechanical, Electrical and Plumbing (MEP) Systems

Table 3. Catalog Descriptions of the MEP Systems Courses

INSTITUTION	MEP COURSE REQUIREMENT	CATALOG DESCRIPTION
Collin County Community College District	CNBT 2340 - Mechanical, Plumbing & Electrical Systems in Construction II (Commercial)	Processes and methods used in design, selection of equipment, and installation of mechanical, plumbing, and electrical systems in commercial buildings. Includes heating and cooling systems, duct work, mechanical and electrical control systems, lighting requirements, and design of water supply and sanitary sewer systems. Additionally, the course addresses MEP blueprints, schedule coordination, and safety.
East Texas A&M University	CONE 221 - Building Construction I	A study of the construction materials and methods used in commercial building projects. Students will examine the selection, acquisition, and utilization of concrete, steel, masonry and wood in a variety of building projects. The course will include introduction to blueprint reading, quantity takeoff, mechanical and electrical systems of building projects.
Lamar University	CMGT 3340 - Industrial and Mechanical Construction	A survey of the systems, including equipment, piping, and materials, used in industrial construction, and applicable codes. Course includes process laboratories, and development of an industrial construction execution plan.
Lamar University	CMGT 3350 - Electrical Systems	Survey of the principles and practices of electrical and electronic systems in residential, commercial, and industrial construction. Includes design, installation, applicable codes, and energy conservation.
Prairie View A&M University	ARCH 3345 - Environmental Systems	Fundamentals of environmental systems for buildings with an emphasis on heating, cooling, and distribution systems.
Sam Houston State University	ETCM 3320. Mechanical, Electrical & Plumbing (MEP) Systems in Buildings	Students design and implement typical Mechanical, Electrical and Plumbing (MEP) systems that are part of residential and commercial construction. Topics include design criteria, installation, and operation methods used to conserve both energy and water in buildings.
Stephen F. Austin State University	CMGT 3117 - Mechanical, Electrical & Piping	This 1-credit hour lecture is designed to introduce students to the basic principles of mechanical, electrical, and piping (MEP) systems common to construction projects. It involves basic science principles of MEP systems, basic design principles of MEP systems, and understanding of the MEP components and installation. Students are required to have a laptop and utilize required software
Stephen F. Austin State University	CMGT 3317 - Mechanical, Electrical & Piping Lab	This 3-credit hour lab course is designed to introduce students to the basic principles of mechanical, electrical, and piping (MEP) systems common to construction projects. It involves basic science principles of MEP systems, basic design principles of MEP systems, and understanding of the MEP components and installation. The lab is a hands-on application of all three systems. Students are required to have a laptop and utilize required software

INSTITUTION	MEP COURSE REQUIREMENT	CATALOG DESCRIPTION
Tarleton State University	CNST 3301 - Building Mechanical and Electrical Systems	This course introduces students to the planning and construction of mechanical and electrical systems common to construction projects. It involves basic calculations of cooling/heating loads, determination of temporary power demands, and sizing of pipes, HVAC equipment, and ducts.
Tarleton State University	CNST 3309 - Commercial Construction and Industrial Subsystems	This course introduces students to the terminology and functions of details of mechanical and electrical systems common to process and industrial plant projects. It involves basic calculations of systems, determination of power requirements, and selection of systems.
Texas A&M University	COSC 325 - Mechanical, Electrical and Plumbing Systems in Construction I	Design, operation, materials and installation methods of mechanical, electrical and plumbing systems in construction
Texas State University	CSM 3367 - Mechanical, Electrical and Plumbing Systems	This course covers typical Mechanical, Electrical and Plumbing (MEPs) systems found in residential and commercial construction along with design and installation methods used to conserve both energy and water in new and remodeled structures.
Texas Tech University	CONE 3302 - MEP Systems and Design for Construction	Introduces students to mechanical, electrical, and plumbing systems in buildings. Includes basic design principles, conservation measures, and green building practices.
The University of Texas at Arlington	CM 3331 - Mechanical & Electrical Systems	Mechanical and electrical systems with a major emphasis on estimating and installation, design and control of the electrical, heating, ventilation and cooling system, site planning and acoustical treatments.
The University of Texas at El Paso	CE 4354 - Electrical and Mechanical Construction	Students in this course will gain an understanding of estimating, bidding, contracting, and operational managing of electrical and mechanical specialty contracting construction work.
The University of Texas at San Antonio	CSM 4643 - Mechanical, Electrical and Plumbing Systems.	Building systems with an emphasis on design, installation and control of heating, ventilation and cooling, plumbing and drainage, electrical, fire and lightning protection systems.
The University of Texas at Tyler	CMGT 3365 - Mechanical, Electrical and Plumbing Systems	Mechanical and electrical systems with a major emphasis on the estimate and installation, design and control of the electrical, heating, ventilation and cooling system, site planning and acoustical treatments.
University of Houston	CNE 4225 - Utility System Construction	Materials, methods and techniques associated with construction of major utility systems, including water, sewer, communications, natural gas and electrical.
University of Houston	CNST 2321 - Mechanical and Electrical Systems	Planning and construction of mechanical and electrical systems common to construction projects.
University of North Texas	CNET 4630 - Construction Management for Mechanical, Electrical and Plumbing (MEP) Systems	Investigation into the integrated approach of managing and scheduling the installation of MEP systems, including the study and analysis of basic mechanical, electrical and plumbing components in construction and their relationships to the overall building.

For the MEP systems course requirements, the following observations can be noted:

- The course requirements range from 1 to 3 credit hours.
- 17% of the required courses are at the 200/2000 level, while 50% are at the 300/3000 level. 22% of the required courses are at the 400/4000 level. 72% of the required courses are offered at the upper level of the construction programs.
- 10 out of 18 (56%) of the required courses combine mechanical, electrical, and plumbing (piping) systems into the same course content. 4 programs (22%) combine mechanical and electrical contents, while one program requires separate mechanical and electrical courses. The Construction Engineering program at the University of Houston requires a "Utility System Construction" course that covers water, sewer, communications, natural gas, and electrical construction from a different perspective. One program utilizes an "environmental systems" course (architecture rubric) that specifically focuses on mechanical (HVAC) systems.
- 15 out of 18 (83%) of the programs only require one course in the MEP topical area. 2 programs require multiple courses (11%), and both of these programs mention "industrial" construction in the second course requirement.
- Stephen F. Austin State University's Construction Management Program is the only program with a required laboratory component offered as a separate course with a concurrent enrollment designation.
- The programs accredited by ACCE and ABET (Engineering, Technology, and Applied and Natural Science) show similar trends in course requirements and content. However, ABET Engineering and Technology programs appear to include more design content (in the course title and description) than the others.

As noted in Table 3, the course content definitions cover a wide range of topics, including plan reading, basic design calculations, materials, methods, estimating, planning, operations, and safety. However, except for the engineering programs, the overall focus is on building construction, system components, materials, and construction methods. It is also important to note that the delivery of the course content would be highly dependent on the instructor's experience and expertise.

SUMMARY AND CONCLUSIONS

This paper aims to provide an organized review of MEP course requirements and content, serving as a baseline for discussion. The review of construction programs in Texas reveals diverse program names, CIP designations, and individual course offerings. The multi-disciplinary and unique nature of construction education is reflected in this observation, including the diversity in professional accreditation preferences. Both ACCE and ABET accreditation criteria allow for flexibility in content and delivery method. It is also important to keep in mind that the student learning outcomes are not specifically attached to individual courses but serve as an instrument for the entire curriculum.

The following items should be noted as major observations from this review:

- 90% of the construction programs require a course with a Mechanical, Electrical, and/or Plumbing (Piping) designation. 56% of these required courses combine mechanical, electrical, and plumbing (piping) systems within a single course, and 22% combine mechanical and electrical content. Plumbing/Piping content appears to be the major system not consistently included in the course descriptions. However, it would be reasonable to assume plumbing/piping-related content is included in the other materials and methods classes.

- 83% of the programs offer only one course in this topical area. The programs that require multiple courses mention an "industrial" construction component. This further illustrates the diversity in the construction program structure, curriculum, and focus. Although the majority of the course descriptions consist of a "building construction" emphasis, there is a "Utility System Construction" course in the University of Houston's construction engineering program.

- There is only one program that requires a laboratory course to be delivered concurrently with the lecture. This may be one area the construction programs could explore; however, the hands-on laboratory option poses logistical and curricular challenges for bachelor-level programs limited to 120 credit hours total.

- For the MEP content, there is no significant difference between the construction engineering/technology programs and the construction management/science programs. However, the delivery of these topics depends on and is greatly influenced by the instructor's preparation and experience.

A limited course and catalog review is not a perfect tool for detailing the components of construction education; however, it provides a strong baseline for discussion. A further analysis and review combining the materials and methods courses with the MEP requirements may further enhance our understanding in this discussion. The frequency of catalog updates and their implementation are limitations of this study, as the information is collected from publicly available university catalogs based on construction-related CIP designations.

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