Engineering Educators Bringing the World Together
2025 ASEE Annual Conference & Exposition
Palais des congrès de Montréal, Montréal, QC • June 22–25, 2025 ASEE
Paper ID #48196

Mathematics and Physics Preparation and Requirements for Construction Programs

Dr. Yilmaz Hatipkarasulu, The University of Texas at San Antonio

Mathematics and Physics Preparation and Requirements for Construction Programs

ABSTRACT

The core curriculum is essential to higher education, ensuring the knowledge and skills needed for a successful college, career, community, and life experience and participation. The construction degree programs include the core curriculum courses as a part of the degree requirements defined by the state, regional accreditation, and professional accreditation procedures. While complying with the accreditation requirements, the construction programs select different sets of mathematics and physics courses, establishing the tone and teaching approach for the technical content of the curriculum. This paper reviews the mathematics and physics core curriculum requirements of construction programs in Texas. As part of this study, the catalog requirements of the construction degree programs are queried for mathematics and physics requirements. The data is presented using rubrics and the common numbering system designations, presenting the patterns and trends. A discussion of the differences among the construction science, management, and technology degree designations is included to highlight the accreditation and structural organization variances.

INTRODUCTION AND BACKGROUND

All construction degree programs include the core curriculum courses as a part of the degree requirements defined by the state, regional accreditation, and professional accreditation procedures. Among these core curriculum courses, the mathematics and physics requirements may vary based on the type of professional accreditation and be influenced by the historical development of the program.

Construction is a multi-disciplinary and application-oriented discipline that is recognized by multiple accreditation agencies, including the American Council for Construction Education (ACCE) [1] and ABET (under engineering, technology, and applied science categories) [2]The accreditation standards define the students' expected mathematics and science preparation to successfully complete the construction-specific teaching and learning objectives. Different accreditation agencies may prescribe different levels/types, but mathematics and science classes are always a requirement at the basic level.

As a relatively young academic discipline, construction programs may show differences in their “origin” stories and their curricula are often influenced by their development and history. 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]. The industry's expectations also play an essential role in shaping educational content, including technical, managerial, and soft skills [5-8]. In 1998, Rosso conducted a study to review the current status of four-year construction education programs and highlighted the evolving approaches and the distinct programs of study under the “construction” umbrella [9]. Discussing

the different teaching and learning approaches, as they relate to the nature of construction practice, is also a focus of attention from an educational perspective [10-12].

The mathematics and science preparation of the students is a critical matter as it would directly impact the remaining construction courses in the curriculum. It is common to hear faculty members discuss issues related to their students' math/physics readiness based on their observed performance in construction classes. In 2011, Davis [13] conducted a study to test the "construction-related" mathematics skills (basic arithmetic, area/volume calculations, etc.) of students in a freshman-level construction management course. The results showed consistent difficulties with "construction-related" mathematics skills, although the students may be qualified to enroll in mathematics classes at the pre-calculus level.

The natural starting point for the mathematics and physics discussion for construction programs is to review the current requirements. This paper reviews the mathematics and physics core curriculum requirements of construction programs in Texas. As part of this study, the catalog requirements of the construction degree programs are queried for mathematics and physics requirements. The data is presented using rubrics and the common numbering system designations, presenting the patterns and trends. A discussion of the differences among the construction science, management, and technology degree designations is included to highlight the accreditation and structural organization variances.

CLASSIFICATION CODES

The National Center for Education Statistics publishes and maintains the Classification of Instructional Programs (CIP) codes [14]. These codes are used to classify programs (identification of the program type) and categorize each course offered by the program [15]. Texas utilizes this taxonomy by overlapping with the first six digits of the national codes and adding 7th and 8th digits when more detail is required in the definitions. In the 2020 Texas CIP code structure [16], the construction programs may be classified under one of the following codes, including two and four-year programs:

- 14 – Engineering
    - 14.3301.00 – Construction Engineering
- 15 –Engineering/Engineering Technologies/Technicians
    - 15.1001.00 – Construction Engineering Technology/Technician
- 19 –Family and Consumer Sciences/Human Sciences
    - 19.0604.00 – Facilities Planning and Management
- 46 – Construction Trades
    - 46.0000.00 – Construction Trades, General
    - 46.0412.00 – Building/Construction Site Management/Manager
- 52 – Business, Management, Marketing, and Related Support Services
    - 52.2001.00 – Construction Management, General
    - 52.2002.00 – Construction Project Management

Texas also uses discipline categories for identification, funding formula, and legislative appropriation purposes, which are noted as a part of the Texas CIP codes [17]. In the 2020 Texas CIP code structure [16], the construction programs may be classified under one of the following disciplines:

- Engineering (06) - to include CIP code 14 (Engineering) and the majority of CIP code 04 (Architecture and Related Services)
- Vocational Training (12) - to include CIP code 46 (Construction Trades)
- Business Administration (16) - to include CIP code 52 (Business, Management, Marketing, and Related Support Services)
- Technology (19) - to include the majority of CIP code 15 (Engineering/Engineering Technologies/Technicians)

CONSTRUCTION PROGRAM DATA

The state of Texas maintains a database of higher education programs through the Texas Higher Education Coordinating Board [18]. The 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 [15].

Table 1. Construction Program Inventory at Bachelor Level [15]

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	Construction Science and Management	15 – Technology
Texas Tech University	Construction Engineering	14 – Engineering
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

At the bachelor level, the distribution changes to 42% under technology (CIP 15), 37% under engineering (CIP 14), 16% under business (CIP 52), and only one program, 5% under construction trades (CIP 46). Tables 1 and 2 also show a variety of program names, which include the words "management," "science," "engineering," "engineering technology," or a combination. It is also significant to observe the unique nature of the program name and CIP code coupling where the "construction management" program title may be linked to technology (CIP 15), engineering (CIP 14), or business (CIP 52). The University of Texas at Tyler,

University of Houston, and University of North Texas offer multiple construction degree programs housed under different academic units.

MATHEMATICS AND PHYSICS REQUIREMENTS

The latest online academic catalogs are reviewed for each program in Table 1 to identify the required mathematics and physics classes associated with the degrees. Table 2 presents the results of the catalog review.

For the mathematics requirements, the following observations can be noted:

- Mathematics requirements range from 3 to 16 credit hours. Texas requires three credit hours to comply with the mathematics element of the state's core curriculum requirements.
- ACCE-accredited and ABET Applied and Natural Science-accredited programs require fewer mathematics credit hours than ABET Engineering and ABET Technology-accredited programs.
- Construction Engineering degrees require the highest mathematics level and total credit hours.
- 8 out of 19 (42%) programs require statistics/statistical method courses as part of the mathematics requirements. A majority of the ACCE-accredited programs utilize statistics/statistical method courses to comply with the state's core curriculum requirement.
- Although a single mathematics course may be listed as the requirement for the degree program, the required course may also include one or more prerequisite courses as preparation or a placement examination.

The following observations can be noted from Table 2 for the physics requirements:

- Physics requirements range from 0 to 14 credit hours. Texas requires six credit hours of the "Life and Physical Sciences" core curriculum element, which includes physics courses as an option.
- Two of the programs did not specify a physics course as a part of the core curriculum requirements; however, when the technical (construction/engineering) curriculum requirements are reviewed, one or more physics courses are noted as a prerequisite to other technical courses.
- 7 out of 19 (37%) programs require a laboratory component coupled with the required physics courses.
- ACCE-accredited and ABET Applied and Natural Science-accredited programs require fewer physics credit hours than ABET Engineering and ABET Technology-accredited programs.
- Some physics courses are listed as an option to satisfy the "component area" of the Texas core curriculum requirements. The "component area option" allows different majors to tailor core curriculum courses based on the disciplinary needs.

Table 2. Mathematics and Physics Requirements for Four-Year Construction Programs

INSTITUTION	PROGRAM NAME	PROFESSIONAL ACCREDITATION AND DEGREE NAME	MATHEMATICS REQUIREMENT	PHYSICS REQUIREMENT
Collin County Community College District	Construction Management	ACCE Candidate Program BAS in Construction Management	MATH 1342 - Elementary Statistical Methods	No specific requirement was noted. Physics courses are listed as "Life & Physical Sciences" general education category option.
East Texas A&M University	Construction Engineering	ABET Engineering BS in Construction Engineering	MATH 2413 - Calculus I MATH 2414 - Calculus II	PHYS 2425 - University Physics I PHYS 2426 - University Physics II
Lamar University	Construction Management	ACCE B.S. in Construction Management	MATH 2312 - Pre Calculus and Elementary Functions BUAL 2305 - Business Analysis I or MATH 1342 – Statistics (Optional)	PHYS 1305 - Elementary Physics I Lecture PHYS 1307 - Elementary Physics II Lecture (Optional)
Prairie View A&M University	Construction Science	ACCE BS in Construction Science	MATH 1314 - College Algebra	PHSC 1315 - Physical Science I PHSC 1317 - Physical Science II
Sam Houston State University	Construction Management	ABET Applied Science BS in Construction Science	MATH 1314 - Pre Calculus Algebra MATH 1316 - Plane Trigonometry MATH 3379 - Statistical Methods in Practice (Optional)	PHYS 1301 & PHYS 1101 - General Phy-Mech & Heat and General Physics Laboratory I PHYS 1302 & PHYS 1102 - Gen Phy-Snd,Lght, Elec, & Mag and General Physics Laboratory II
Stephen F. Austin State University	Construction Management	ACCE Candidate Program BS Construction Management	MATH 1342 - Introduction to Probability and Statistics MATH 1314 - College Algebra	PHYS 1305 - General Physics I PHYS 1105 - General Physics I Laboratory PHYS 1307 - General Physics II PHYS 1107 - General Physics II Laboratory
Tarleton State University	Construction Science and Management	ACCE Candidate Program BAS in Construction Science and Management	MATH 1342 - Elementary Statistical Methods MATH 1352 - Math Applications for Construction Sci	PHYS 1401 - College Physics I (Optional)
Texas A&M University	Construction Science	ACCE BS in Construction Science	MATH 140 - Mathematics for Business and Social Sciences MATH 142 - Business Calculus	PHYS 201 - College Physics
Texas State University	Construction Science and Management	ACCE BS in Construction Science and Management	MATH 2328 - Elementary Statistics MATH 2417 - Pre-Calculus Mathematics	PHYS 1315 & PHYS 1115 - General Physics I and General Physics I Laboratory PHYS 1325 & PHYS 1125 - General Physics II and General Physics II Laboratory
Texas Tech University	Construction Engineering	ABET Engineering BS in Construction Engineering	MATH 1451 - Calculus I with Applications MATH 1452 - Calculus II with Applications MATH 2450 - Calculus III with Applications MATH 3350 - Higher Mathematics for Engineers and Scientists I MATH 3342 - Mathematical Statistics for Engineers and Scientists	PHYS 1408 - Principles of Physics I
The University of Texas at Arlington	Construction Management	ABET Applied and Natural Science BS in Construction Management	MATH 1303 - Trigonometry MATH 1308 - Elementary Statistical Analysis	PHYS 1441 - General College Physics I PHYS 1442 - General College Physics II
The University of Texas at El Paso	Construction Engineering and Management	ABET Engineering BS in Construction Engineering and Management	MATH 1411 - Calculus I MATH 1312 - Calculus II MATH 2313 - Calculus III CE 2373 - Eng. Prob. & Stat. (IE 3373)	No specific requirement was noted. A Physics course is a prerequisite to a required mechanical systems course.

INSTITUTION	PROGRAM NAME	PROFESSIONAL ACCREDITATION AND DEGREE NAME	MATHEMATICS REQUIREMENT	PHYSICS REQUIREMENT
The University of Texas at San Antonio	Construction Science and Management	ACCE BS in Construction Science and Management	STA 1053 - Basic Statistics AND one of the following CS 1173 - Data Analysis and Visualization MAT 1023 - College Algebra with Applications MAT 1043 - Quantitative Reasoning MAT 1053 - Mathematics for Business MAT 1073 - Algebra for Scientists and Engineers MAT 1093 - Precalculus MAT 1133 - Calculus for Business MAT 1193 - Calculus for the Biosciences MAT 1213 - Calculus I	PHY 1603 - Algebra-based Physics I
The University of Texas at Tyler	Construction Engineering	Professional Accreditation not Noted (New Program) BS in Construction Engineering	MATH 2413 - Calculus I MATH 2414 - Calculus II MATH 3351 - Probability and Statistics for Engineers and Scientists	PHYS 2325 - University Physics I PHYS 2326 - University Physics II PHYS 2126 - University Physics II Laboratory
The University of Texas at Tyler	Construction Management	ABET Applied and Natural Science BS in Construction Management	MATH 2312 - PreCalculus MATH 1324 - Math for Business and Economics I MATH 1342 - Statistics	PHYS 1301 - College Physics I PHYS 1101 - College Physics I Lab
University of Houston	Construction Engineering	ABET Engineering BS in Construction Engineering	MATH 1431 - Calculus I MATH 1432 - Calculus II MATH 2433 - Calculus III MATH 3321 - Engineering Mathematics	PHYS 1321 - University Physics I PHYS 1322 - University Physics II
University of Houston	Construction Management	ACCE BS in Construction Management	MATH 2413 - Calculus I MATH 2312 - Precalculus MATH 1324 - Finite Math with Applications MATH 1342 - Elementary Statistical Methods	PHYS 1301 - College Physics I (lecture) PHYS 1302 - College Physics II (lecture)
University of North Texas	Construction Engineering Technology	ABET Technology BSET in Construction Engineering Technology	MATH 1710 - Calculus I MATH 1720 - Calculus II	PHYS 1710 - Mechanics and PHYS 1730 - Laboratory in Mechanics PHYS 2220 - Electricity and Magnetism PHYS 2240 - Laboratory in Electricity and Magnetism
University of North Texas	Construction Management	ACCE Candidate Program BS in Construction Management	MATH 1190 - Business Calculus or MATH 1710 - Calculus I	PHYS 1410 - General Physics I and PHYS 1430 - General Physics Laboratory I or PHYS 1710 - Mechanics and PHYS 1730 - Laboratory in Mechanics and PHYS 1420 - General Physics II and PHYS 1440 - General Physics Laboratory II or PHYS 2220 - Electricity and Magnetism and PHYS 2240 - Laboratory in Electricity and Magnetism

SUMMARY AND CONCLUSIONS

This paper aims to provide an organized review of the mathematics and physics requirements of the construction programs in Texas. The review shows the diversity of program names, program CIP designations, and individual course offerings, illustrating the multi-disciplinary and unique nature of construction education. This diversity is also a reflection of the different educational approaches. Although the ACCE and ABET accreditation standards would have a minimum mathematics and physical science requirement, the accreditation process relates to the entire curriculum for a degree program. It is assessed mainly by the learning outcomes rather than the individual course offerings.

As a part of the discussion, the following issues must be noted:

- There is a clear difference between the construction engineering/technology programs and the construction management/science programs. The engineering/technology programs require a higher number of credit hours and level of mathematics courses. This would be expected from any engineering degree program.
- 42% of the programs require statistics/statistical method courses as part of the mathematics requirements. A majority of the ACCE-accredited programs utilize statistics/statistical method courses to comply with the state's core curriculum requirement, while the engineering/technology programs require multiple levels of calculus.
- The difference between engineering/technology and management/science programs is less pronounced for physics requirements. It is possible to argue that construction programs require physics content in preparation for their higher-level statics/structural analysis/design courses. The content and nature of these courses would dictate the prerequisite physics preparation.
- Only 37% of the programs require a laboratory component coupled with the required physics courses. This may be a reflection of the available course offerings or the credit hour limitations defined by the state for each core curriculum element.
- The program's origins may have a significant impact on the required course definitions. A construction program with an architecture or engineering background is more likely to include a higher number of mathematics and physics requirements. The program's organizational structure is also a factor in this discussion. The construction program's department/school/college affiliation may directly impact the definitions. If a program is housed in an engineering department/school/college, it may simply follow the department/school/college-level requirements for all students in the unit.
- Only two programs did not specifically require a physics course as part of the core curriculum. This may be considered a serious concern, but both programs define physics as a prerequisite to other technical courses, making the content an indirect requirement.

The information and data presented in this paper are collected from the publicly available university catalogs based on construction-related CIP designations. This is a limitation of the study since the frequency of catalog updates and implementation may directly impact the observations presented in this paper.

A limited core curriculum and catalog review is not a perfect tool for detailing the status of construction education; however, it provides insight into how the programs are structured. Using a similar approach, a topical content comparison may provide a further understanding of the programs. For example, analyzing the relationship between the physics course requirements (and content) and the required statics/structural analysis/design courses would be insightful.

REFERENCES

[1] ACCE. "Accredited Degree Programs." American Council for Construction Education. https://www.acce-hq.org/accredited-degree-programs (accessed 2022).

[2] ABET. "ABET Accredited Programs." ABET. https://www.abet.org/ (accessed 2022).

[3] R. A. Burt, Y. Hatipkarasulu, and M. C. Nobe, "Evolution of Construction Education in the United States: Two Case Studies," in *Proceedings of the 57th Annual Conference, Associated Schools of Construction*, Auburn, AL, 2008.

[4] R. A. Burt and Y. Hatipkarasulu, "Evolution of Construction Education in the United States: A Case Study," in *Proceedings of the Construction and Building Research Conference of the Royal Institution of Chartered Surveyors, RICS COBRA*, Atlanta, GA, 2007.

[5] Y. H. Ahn, R. P. Annie, and H. Kwon, "Key competencies for US construction graduates: Industry perspective," *Journal of Professional Issues in Engineering Education and Practice,* vol. 138, no. 2, pp. 123-130, 2012.

[6] L. Gao and N. Eldin, "Employers' expectations: A probabilistic text mining model," *Procedia Engineering,* vol. 85, pp. 175-182, 2014.

[7] J. K. Mahasneh and W. Thabet, "Rethinking construction curriculum: Towards a standard soft skills taxonomy," in *Proceedings of the 52nd Annual International Conference, Associated Schools of Construction*, Provo, UT, 2016.

[8] D. R. Simmons, C. McCall, and N. A. Clegorne, "Leadership competencies for construction professionals as identified by construction industry executives," *Journal of Construction Engineering and Management,* vol. 146, no. 9, p. 04020109, 2020.

[9] L. L. Rosso, *The current status of four-year undergraduate construction education programs in the United States*. Louisiana State University, Baton Rouge, LA, 1998.

[10] T. Mills and Y. Beliveau, "E10: Why is Construction Education so Backwards?," in *2007 Construction Research Congress, American Society of Civil Engineering*, Freeport, Bahamas, 2007.

[11] C. J. Schexnayder and W. W. Badger, "Full Circle in Construction Education?," in *2003 Construction Research Congress, American Society of Civil Engineering*, Honolulu, HI, 2003.

[12] J. Woudhuysen and I. Abley, *Why is construction so backward?* Academy Press, 2004.

[13] K. A. Davis, "A survey of construction-related math skills in an introductory-level construction management course," in *2011 ASEE Annual Conference & Exposition*, 2011, pp. 22.114. 1-22.114. 8.

[14] NCES. "CIP - The Classification of Instructional Programs." National Center for Education Statistics, US Department of Education. https://nces.ed.gov/ipeds/cipcode/ (accessed 2022).

[15] Y. Hatipkarasulu and G. Hatipkarasulu, "An Organizational Review of CIP Code Designations for Construction Science, Technology, Engineering, and Management Programs and Curriculum," in *2022 ASEE Annual Conference & Exposition*, Minneapolis, MN, 2022: American Society of Engineering Education. [Online]. Available: https://peer.asee.org/41418. [Online]. Available: https://peer.asee.org/41418

[16] THECB. "2020 Texas CIP Codes." Texas Higher Education Coordinating Board. http://www.txhighereddata.org/Interactive/CIP/ (accessed 2025).

[17] THECB. "Formula Funding." Texas Higher Education Coordinating Board. https://www.highered.texas.gov/institutional-resources-programs/funding-facilities/formula-funding/ (accessed 2025).

[18] THECB. "Program Inventory Search." Texas Higher Education Coordinating Board. https://www.highered.texas.gov/apps/programinventory/ProgSearchForm.cfm (accessed 2025).