

# BUILDING CONSTRUCTION

Our Website (<http://www.bc.vt.edu>)

## Overview

The Myers-Lawson School of Construction offers students in the College of Engineering a Bachelor of Science in Building Construction (BC). The curriculum focuses on the business and process of making, managing, assembling, and the performance of buildings, including their operations, finance, energy use, and sustainability. The BC degree options are designed to better equip construction industry professionals with the necessary tools for excellence in all phases of the built environment. The degree incorporates business, management, science, and efficiency at all levels; from planning, finance, design, estimating, procurement, scheduling, construction, and maintaining buildings necessary to the way our world will be built and lived in during the future.

Throughout their studies, students will explore all phases of a building construction project, from initial planning to final execution. Core courses cover construction means and methods, materials, cost estimating and scheduling, new technologies, project delivery, and cost and risk management. They will learn how to manage construction projects, including organization, scheduling, budgeting, and implementation. Integrative elements of leadership, professional and presentation skills, entrepreneurship, and best practice management principles are included to prepare graduates to work effectively as part of a construction team. A capstone course is a requirement for all students, providing a culminating experience to apply the concepts learned.

## Accreditation

The Bachelor of Science in Building Construction degree offered by Building Construction is accredited by American Council for Construction Education (ACCE).

## Program Educational Objectives

The Program Educational Objectives of Building Construction are that, within a few years of program completion, graduates should be effectively serving society as construction professionals by:

- reviewing design elements to optimize project constructability, collaborating with architects, engineers, owners, and other stakeholders by application of teamwork, and professional and ethical behaviors.
- analyzing data and preparing cost estimates, budgets, and schedules, interpreting contracts and technical information, and ensuring the project complies with all legal requirements and codes.
- monitoring projects, responding to work delays, and incorporating safety, environmental sensitivity, and social awareness into all operations and processes.
- innovating new technologies within vertical structures and optimizing the performance and sustainability of these structures.

## Student Outcomes

Upon completion of the undergraduate program curriculum in Building Construction, students will be able to:

1. Create written communications appropriate to the construction discipline.
2. Create oral presentations appropriate to the construction discipline.

3. Create a construction project safety plan.
4. Create construction project cost estimates.
5. Create construction project schedules.
6. Analyze professional decisions based on ethical principles.
7. Analyze methods, materials, and equipment used to construct projects.
8. Apply electronic-based technology to manage the construction process.
9. Apply basic surveying techniques for construction layout and control.
10. Understand different methods of project delivery and the roles and responsibilities of all constituencies involved in the design and construction process.
11. Understand construction accounting and cost control.
12. Understand construction quality assurance and control.
13. Understand construction project control processes.
14. Understand the legal implications of contract, common, and regulatory law to manage a construction project.
15. Understand the basic principles of sustainable construction.
16. Understand the basic principles of structural behavior.
17. Understand the basic principles of HVAC, electrical, and plumbing systems.

## Curriculum

Virginia Tech fosters a “experiential learning” approach to education to prepare scholars to be leaders in their fields and communities. This approach to learning has always been the department’s philosophy as our students actively transform knowledge to practice through labs and the platform of the integrated construction studio course series.

The “Integrated Construction Series (ICS)” courses, unique among our peer institutions, are an example of integrative learning. Each semester, the ICS course brings together Construction Engineering and Management (CEM) juniors and seniors and Building Construction (BC) sophomores, juniors, seniors and graduate students to conduct pre-construction management of a real project. Students within each grade level form teams of three to six members, which are then paired in larger teams of one sophomore team (structural sub-contractors), one junior team (mechanical sub-contractors) and one mixed senior/graduate team (general contractors) each. Teams work together throughout the semester, culminating in a competitive, formal bid for a construction project similar to the bidding process construction companies undertake. The studio environment for the ICS course allows it to be catered to teams while at the same time also challenging individual students.

- Building Construction Major (<https://catalog.vt.edu/undergraduate/college-engineering/building-construction/building-construction-bs/>)

**Vorster-Kleiner Director:** B Kleiner<sup>1</sup>

**Chair:** T. Bulbul

**Graduate Program Director:** J. Iorio

**Beliveau Professor:** A.P. McCoy

**William E. Jamerson Professor:** W.Y. Thabet

**Associate Professors:** P. Agee, T. Bulbul, A.R. Pearce<sup>2</sup>, N. Roofigari-Esfahan<sup>3</sup>, X. and L. Zhang

**Assistant Professors:** A. Shojaei and A. Alzarrad

**Collegiate Assistant Professors:** X. Lv

**Assistant Professor of Practice:** J. Bluey, M. Oliver, and J. Withers

**Adjunct Faculty:** R. Clark and W. Thumm

**Professors Emeritus:** Y. Beliveau and T. Mills

**Academic Advisors:** S. Norwood<sup>4</sup>

**Footnotes:**

<sup>1</sup>Construction Industry Institute Distinguished Professor, National Academy of Construction member

<sup>2</sup>Alumni Award for Outreach Excellence

<sup>3</sup>XCaliber Award; Diggs Teaching Scholar

<sup>4</sup>Provost's Award for Excellence in Advising

## Undergraduate Course Descriptions (BC)

### **BC 1014 - Building A Strong Foundation for Success (2 credits)**

Exploration of career options within the built environment and construction industry. Professional development, digital literacy, which will include creation of media and "personal brand" identity. Exploration of ideas from multiple viewpoints and perspectives. Oral, written, and visual presentation of ideas such as resume development. Introduction to ethical considerations. Reflection on "Self-as-Learner." Critical-Thinking skills as they apply to construction projects. Development of group roles as they apply to construction projects. Identification of universities resources, policies, procedures, academic and social engagement opportunities.

**Instructional Contact Hours:** (2 Lec, 2 Crd)

### **BC 1114 - Introduction to Building Construction (3 credits)**

Introduction to construction with understanding of different market sectors, specializations, career path opportunities, industry stakeholders, and processes. Comprehension of quality assurance, control, project delivery systems, basic estimating, and scheduling. Application of communication skills to professional settings and use of basic calculations to solve construction math problems.

**Instructional Contact Hours:** (3 Lec, 3 Crd)

### **BC 1124 - Construction Documents and Safety (2 credits)**

Role of construction drawings and specifications. Interpretation of construction documents and creation of basic project documentation. Health, safety, and environmental hazards encountered in the construction industry. Design Lab Studio (1H, 2L, 2C)

**Instructional Contact Hours:** (1 Lec, 2 Lab, 2 Crd)

### **BC 1214 - Introduction to Building Construction I (3 credits)**

Introduction to construction with an overview of construction drawings and specifications, construction terminology, building codes and building systems, cost estimating and bidding, construction management processes, construction documents, load paths and foundations, construction health and safety, and hands-on experiential learning through lab exercises. Strategic career success factors and introduction to ethical decisions in construction management.

**Instructional Contact Hours:** (2 Lec, 3 Lab, 3 Crd)

### **BC 1224 - Introduction to Building Construction II (3 credits)**

Overview of the important areas of contracting and the workings of the construction industry. Application of construction management theory, processes, and terminology including, definable building systems, building code interpretations, the reading and preparing of basic construction drawings and integrating construction details and project specifications to derive safe construction means and methods, equipment section, cost estimates and time schedules.

**Prerequisite(s):** BC 1214 or BC 1114

**Instructional Contact Hours:** (2 Lec, 3 Lab, 3 Crd)

### **BC 2004 - Construction Surveying (1 credit)**

Surveying in context of the construction process, basic surveying methods, equipment, emerging technologies, topographic surveying, and application to construction layout.

**Prerequisite(s):** BC 1124

**Instructional Contact Hours:** (1 Lec, 1 Crd)

### **BC 2014 - Construction Principles I (3 credits)**

Fundamentals of the construction technology and process emphasizing project management/operations, materials and methods. Utilization of industry-specific technology/software applications, techniques and sequences/project loading for the construction of buildings in compliance with Construction Specifications Institute (CSI) Divisions 00-05, 31, 32, 33. Planning, scheduling, materials cost analysis, job-appropriate equipment and labor requirements, masonry applications, concrete and formwork. Site preparation and utilization, use of construction industry-specific software, interpretation of project drawing documents. Integration of project safety and health issues. Quantity surveying for the management of construction resources, according to current principles and industry standards.

**Prerequisite(s):** BC 1224 or BC 1124

**Instructional Contact Hours:** (2 Lec, 3 Lab, 3 Crd)

### **BC 2024 - Construction Principles II (3 credits)**

Continuation of the fundamentals of construction technology and process emphasizing materials, methods, techniques and sequences for the construction of buildings using Construction Specifications Institute (CSI) Divisions 01, 06-14, 21. Interpretation of construction details relevant to a construction project. Cost impact of building codes and inspections. Development of presentation skills using project-based learning. Planning, scheduling, labor needs, and quantity surveying for the management of construction resources. Development of safety and quality assurance plans, including building systems for fire suppression.

**Prerequisite(s):** BC 2014

**Corequisite(s):** BC 2064

**Instructional Contact Hours:** (3 Lec, 3 Crd)

### **BC 2044 - Construction Materials (3 credits)**

Introduction to the life cycle, properties, behaviors, and sustainability impacts of common construction materials including wood, insulation, asphalt, ferrous and nonferrous metals, aggregate, concrete, masonry, glass, and plastics. Theory of materials including material properties; behavior under physical, thermal, and environmental loads; and interfaces between dissimilar materials. Methods and criteria for material comparison and selection for sustainable construction. Preparation of professional written reports as a team and individually; Project management for materials selection/application.

**Corequisite(s):** BC 2214

**Instructional Contact Hours:** (2 Lec, 3 Lab, 3 Crd)

### **BC 2064 - Integrated Construction I (3 credits)**

Application of construction means, materials and methods related to quantity take-off, cost management, scheduling, resource management, document drawing, building information modeling in support of a selected project. Project cost impact of building code requirements. Emphasis on structural components of selected project.

**Prerequisite(s):** BC 2014 and BC 2114

**Instructional Contact Hours:** (3 Lec, 3 Crd)

**BC 2104 - Building Effective Construction Teams (3 credits)**

Introduction to leadership behavior styles and their impact on construction management team performance, including analysis of how ethical behavior and individual strengths support positive relationship-building. Development of management strategies to maximize positive conflict outcomes through trust-building between construction project stakeholders. Identification of the role that implicit bias plays in decision-making within diverse project teams. Development of presentation skills for a construction audience.

**Prerequisite(s):** BC 1224 or BC 1124

**Instructional Contact Hours:** (3 Lec, 3 Crd)

**BC 2114 - Information Technology in Design and Construction (3 credits)**

Building delivery and project management improvements through the use of information technology (IT) are explored, including scheduling software, building information modeling (BIM) tools, and virtual design and construction (VDC) simulation software and their corresponding theories and concepts that integrate design and construction. Use BIM/VDC tools for graphical presentations, databases, and spreadsheets.

**Prerequisite(s):** BC 1224 or CEM 2104 or BC 1124

**Corequisite(s):** BC 2014

**Instructional Contact Hours:** (3 Lec, 3 Crd)

**BC 2134 - Construction Data Analysis (2 credits)**

Identification and use of various types and sources of construction market data and the tools for analyzing construction data to support managerial decision making. Different forms of applying mathematics to the construction market for better productivity and processes across the construction industry. Develop insights to inform management and investment decisions. Use of cost-benefit analysis as applied to construction management in determining feasibility of projects.

**Prerequisite(s):** MATH 1025 or MATH 1225

**Instructional Contact Hours:** (2 Lec, 2 Crd)

**BC 2214 - Why Buildings Stand Up (3 credits)**

Overview of fundamental principles explaining why structures remain stable under various loading conditions. Explores different types of structures and applied loads and analyzes both determinate and indeterminately supported structures. Calculation of shear, bending moments, deflections in beams, and buckling. Discussion of ethical impacts on user safety and hazard avoidance, in project design and construction methods, materials, etc. Explores different types of soil composition and their strength properties.

**Prerequisite(s):** (BC 1224 or BC 1124) and (MATH 1025 or MATH 1225)

**Pathway Concept Area(s):** 5A Quant & Comp Thnk Adv., 10 Ethical Reasoning

**Instructional Contact Hours:** (3 Lec, 3 Crd)

**BC 2354 - Residential Construction Technologies (3 credits)**

Identify and evaluate conventional construction materials, methods, building systems, and products to less-familiar, innovative technological alternatives for a specific residential construction project. Compare innovative technological alternatives with material and cost estimates. Overview of conventional materials, equipment, designs, and processes in residential construction. Investigate recent literature on emerging technologies to determine best practices. Strengthen understanding of the primary building systems in residential construction applications.

**Prerequisite(s):** BC 2064

**Instructional Contact Hours:** (3 Lec, 3 Crd)

**BC 2974 - Independent Study (1-19 credits)**

**Instructional Contact Hours:** Variable credit course

**BC 2984 - Special Study (1-19 credits)**

**Instructional Contact Hours:** Variable credit course

**BC 3014 - Building Physics and Environmental Systems (3 credits)**

Theory and analysis methods relative to performance of envelope systems and the design and integration of mechanical and electrical building systems. Topics covered include: envelope systems and performance metrics, conceptual and technical design theory, operational principles, and maintenance issues, all necessary for determining the selection of passive and active environmental control systems within a building including: envelope system, heating, ventilation, air conditioning, lighting, and acoustical systems.

**Prerequisite(s):** PHYS 2205 and PHYS 2215 or PHYS 2305

**Instructional Contact Hours:** (3 Lec, 3 Crd)

**BC 3064 - Integrated Construction II (3 credits)**

Application of construction means, materials and methods as they relate to quantity take-off, cost management, scheduling and resource management, document drawing, building information modeling in support of a selected project. Emphasis on building systems components of selected project.

**Prerequisite(s):** (BC 2064 or CEM 2104) and (PHYS 2205 and PHYS 2215 or PHYS 2305)

**Corequisite(s):** BC 3114

**Instructional Contact Hours:** (3 Lec, 3 Crd)

**BC 3114 - Building Systems Technology (3 credits)**

Emphasis is placed on the integration and physical installation of passive and active environmental control systems including: heating, ventilation, air conditioning, lighting, acoustics, plumbing, and fundamentals of thermal loads.

**Prerequisite(s):** BC 2024 and (PHYS 2305 or PHYS 2205 and PHYS 2215) or (CEM 2104 and PHYS 2305)

**Instructional Contact Hours:** (2 Lec, 3 Lab, 3 Crd)

**BC 3134 - Temporary Structures in Construction (3 credits)**

Introduction to temporary structure systems used to support construction operations. Concrete formwork, scaffolding systems, excavation shoring systems, dewatering techniques, and hoisting operations. Assessment of systems, cost, quality, safety, sustainability, and schedule impacts.

**Prerequisite(s):** (BC 2044 and BC 2024 and BC 2214) or CEE 3684

**Instructional Contact Hours:** (3 Lec, 3 Crd)

**Course Crosslist:** CEM 3134

**BC 3954 - Study Abroad (1-19 credits)**

Study abroad in Spain.

**Instructional Contact Hours:** Variable credit course

**BC 3984 - Special Study (1-19 credits)**

**Instructional Contact Hours:** Variable credit course

**BC 4024 - Estimating, Production, and Cost Engineering (3 credits)**

Interpretation of plans and specifications, preparation of construction estimates, and cost control. Methods analysis, resource requirements, and resource costs in building systems, including system components, and in large-scale civil engineering works such as highways, bridges, and hydraulic structures.

**Prerequisite(s):** CEE 3014

**Instructional Contact Hours:** (3 Lec, 3 Crd)

**Course Crosslist:** CEE 4014

**BC 4064 - Integrated Construction III (3 credits)**

Application of construction means, materials and methods as they relate to quantity take-off, cost management, scheduling and resource management, document drawing, building information modeling in support of a selected project. Emphasis on administrative/general contractor functions (such as project safety, budget development, and permitting) of the selected project.

**Prerequisite(s):** BC 3064

**Instructional Contact Hours:** (3 Lec, 3 Crd)

**BC 4114 - Building Information Modeling in Design and Construction (3 credits)**

Introduction to means and methods to enrich the geometric information of a building model with semantic data such as, material, structural and performance values. Concept of interoperability in architecture, engineering and construction industry. Overview of approaches to information modeling such as Standard for the Exchange of Product model data (STEP), Industry Foundation Classes (ifc), Construction Operations Building Information Exchange (COBie) and Green Building XML (gbXML). Key concepts of object-oriented modeling and programming.

**Prerequisite(s):** BC 2114 or (ENGE 1215 and ENGE 1216)

**Corequisite(s):** CS 1014

**Instructional Contact Hours:** (3 Lec, 3 Crd)

**BC 4124 - Digital Construction & Manufacturing (3 credits)**

Explore working principles, design projects, & experiment with construction digital information modeling, computer numerical control (CNC), and computer aided manufacturing (CAM) processes. Fundamentals of digital prototyping. Analysis of the industry tools such as 3D scanners, 3D printers, CNC manufacturing techniques, and others, used to provide familiarity with technologies & provide understanding of their benefits & limitations.

**Prerequisite(s):** BC 2114

**Instructional Contact Hours:** (3 Lec, 3 Crd)

**BC 4164 - Production Planning and Process Design for Construction (3 credits)**

The course deals with the planning and design of construction processes. Course topics include production systems, behavior of construction systems and workers, the relationships between subsystems in the construction process, queuing systems, process modeling and simulation. The major emphasis is on production and productivity. Production problems that typically occur in construction systems are discussed. The course also explores recent innovations in construction system design such as lean construction and agile construction.

**Prerequisite(s):** BC 3064

**Instructional Contact Hours:** (3 Lec, 3 Crd)

**BC 4174 - Decision Making and Risk Management (3 credits)**

Explores the theories, methodologies, and tools used in decision making and risk management, with a focus on applications in the construction industry. Students will gain insights into the complexities of making decisions in uncertain project environments and learn strategies to identify, assess, and mitigate risks effectively throughout the project lifecycle. Pre: Junior/Senior Standing

**Instructional Contact Hours:** (3 Lec, 3 Crd)

**BC 4264 - Fundamentals of Construction Management (6 credits)**

Practical construction management methods within the built environment. Construction materials, document drawings, management activities, fundamentals of construction scheduling and planning. Quality, quantity, and cost of materials necessary to complete a construction project. Construction information technology tools. Partially duplicates BC 2014 and 2114. Pre: Junior Standing.

**Instructional Contact Hours:** (6 Lec, 6 Crd)

**BC 4314 - Building Performance and Energy Management (3 credits)**

Fundamentals of building performance mandates for the built environment. Practical means and methods for evaluating building performance metrics within integrated design including acoustic performance, visual performance, and indoor air quality and management. Specific focus on energy resources consumed by thermal, hygrothermal, lighting, and other environmental building systems. Assessment of building energy consumption and analysis of retrofit scenarios through performance evaluation over the entire building life cycle.

**Prerequisite(s):** BC 3014

**Instructional Contact Hours:** (3 Lec, 3 Crd)

**BC 4324 - Innovation in Residential Construction (3 credits)**

Mechanisms of historical and current innovations in the residential construction industry. Theory and application within the realms of innovation, diffusion, technology, adoption, new product development, housing innovation literature, supply chain management, sustainability, information technology, commercialization, and housing policy. Innovation theories and applications to residential construction through the analysis and utilization of data-driven hypotheses typical to the industry.

**Prerequisite(s):** BC 2354 and BC 3064

**Instructional Contact Hours:** (3 Lec, 3 Crd)

**BC 4334 - Sustainable Building Performance Management (3 credits)**

Introduction to means and methods for managing the sustainability of buildings and their performance over the life cycle. Best practices for sustainable projects in the areas of planning/development, site design, project management, energy and water conservation and green building assessment tools and methods; Leadership in Energy and Environmental Design (LEED) rating system; economic analysis of green building alternatives; and implementation planning.

**Prerequisite(s):** BC 3064 and BC 3014

**Instructional Contact Hours:** (3 Lec, 3 Crd)

**BC 4364 - Lifecycle BIM for Facility Management (3 credits)**

BIM (Building Information Modeling) concepts and tools that are critical for facility operation and maintenance. Identifying, capturing, analyzing, exporting and exchanging facility lifecycle data. Spreadsheet-based and BIM based facility management platforms. Case studies and real-life application for understanding mechanical, electrical, and plumbing systems from an owner or facility manager perspective. Workflow processes for data exchange.

**Prerequisite(s):** BC 2114 and BC 3114

**Instructional Contact Hours:** (3 Lec, 3 Crd)

**BC 4374 - Residential Housing and Land Development (3 credits)**

Application of means, methods, and strategies for delivering single and multi-family residential housing in urban and suburban contexts. Project planning, including market analysis to determine highest and best use of an identified property, marketing and sales strategies, site and product design and procurement, infrastructure requirements, zoning and government agency regulations, financial analysis and feasibility study, financing strategies, and delivery control systems. Roles of developer and project team in preparing formal proposals for a housing development to be submitted for financing. Identification and application of interfaces with project stakeholders. Overview of contemporary topics such as green development and affordable housing.

**Prerequisite(s):** BC 2354 and BC 3064

**Instructional Contact Hours:** (3 Lec, 3 Crd)

**BC 4434 - Construction Practice I (3 credits)**

Explores advanced business and management practices and applications to vertical construction projects. Topics include scope, planning and scheduling, assemblies estimating, cash flow controls. Creation of work breakdown structure, application of concepts of assemblies estimating and general conditions to interpret insurance and contract requires along with digital construction practices.

**Prerequisite(s):** BC 3064 and BC 3114 and BC 3134

**Corequisite(s):** BC 4064

**Instructional Contact Hours:** (3 Lec, 3 Crd)

**BC 4444 - Construction Practice II (4 credits)**

This course explores and applies the business and construction practices related to operation of a construction company to a capstone experience. Construction operation is examined as it relates to construction, financial and personnel management. Project management topics studied in this course are applied in the corequisite lab. This course is formally designated as a writing intensive course. Formal written and edited and oral presentations are presented and critiqued by the BC faculty team, the writing resource center, students and industry professionals.

**Prerequisite(s):** BC 4434

**Instructional Contact Hours:** (3 Lec, 3 Lab, 4 Crd)

**BC 4754 - Internship (1-3 credits)**

**Instructional Contact Hours:** (1-3 Lec, 1-3 Crd)

**Repeatability:** up to 3 credit hours

**BC 4974 - Independent Study (1-19 credits)**

**Instructional Contact Hours:** Variable credit course

**BC 4984 - Special Study (1-19 credits)**

**Instructional Contact Hours:** Variable credit course

**BC 4994 - Undergraduate Research (1-19 credits)**

**Instructional Contact Hours:** Variable credit course