BALL STATE UNIVERSITY — Fall Semester 2025

Department of Architecture

ARCH 373 Environmental Systems 2 (3)
Application of the principles of physics to the design and engineering of environmental systems in buildings and technologies of active intervention.
Prerequisite: ARCH 273
Open only to B. ARCH; BA/BS architecture; BA/BS environmental design.

CONTACT INFORMATION

Instructors:

Tom Collins, PhD, AIA, LEED AP
Email: tdcollins@bsu.edu
Office tel: 765-285-2028
Office: AB 426A (across from the double elevators)
Office Hours: By appointment via email
Pronouns: he/him

Graduate Assistant (GA):

Duro Ajidagba
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GENERAL CURRICULAR OBJECTIVES

(1) Terminology: Awareness of basic environmental systems terminology, performance metrics, building codes, and standards, and the architectural form-giving role that environmental systems can play in design
(2) Form: Understanding the architectural form-giving role that environmental systems can play in design
(3) Systems: Awareness of basic active environmental systems: types, functions, selection, components, sizing, and integration
(4) Processes: Understanding the integrated design processes that involve issues related to building design, systems coordination, and operations
(5) Sustainability: Understanding how building systems and services relate to broader environmental, social, and economic concerns, efforts, and initiatives
(6) Evaluation: Understanding of how to evaluate & compare specific active environmental system products in detail on the basis of cost, performance, standards compliance, usability, etc.

By achieving these course outcomes, you simultaneously satisfy NAAB accreditation criteria for your program and gain NACE workplace competencies. See below for the NACE definitions and NAAB criteria descriptions.

Course Objectives	NACE Workplace Competencies	NAAB Accreditation Criteria
Terminology	Career & Self-development, Communication	SC.1 Health, Safety, & Welfare in the Built Enviro.
Form	Career & Self-development, Communication	
Systems	Career & Self-development, Communication, Teamwork, Technology	SC.4 Technical Knowledge
Processes	Career & Self-development, Communication, Critical Thinking	PC.5 Research & Innovation SC.4 Technical Knowledge SC.6 Building Integration
Sustainability	Career & Self-development, Communication, Equity & Inclusion, Critical Thinking, Technology	PC.3 Ecological Knowledge & Responsibility
Evaluation	Career & Self-development, Communication, Critical Thinking, Leadership, Professionalism, Teamwork	PC.5 Research & Innovation SC.4 Technical Knowledge

INSTRUCTIONAL MATERIALS

- Required Text: *Mechanical and Electrical Equipment for Buildings (MEEB)*: 13th edition (2019)
- Recommended Text: *The Green Studio Handbook*: 3rd edition (2018)
- Other course readings will be uploaded to Canvas for your use. Refer to the course schedule for readings.
- Supplementary instructional materials provided when necessary:
    - Access to free web-based tools such as the CBE Comfort Tool & PV Watts Calculator
    - Access to proprietary performance modeling software such as Cove.Tool
    - Access to free downloadable software application such as Climate Consultant & Opaque
- We will take several campus field trips to see the AB mechanical systems, the Ball State geothermal heat pump system, etc.
- Students will build a luminaire prototype in small groups and there will be cost associated with this project.
- Link to library course reserves: https://bsu.alma.exlibrisgroup.com/leganto/public/01BSU_INST/lists?courseCode=202510.11845.ARCH.373.1.M.01.CLAS&auth=SAML

**The course text is available on reserve in the library and as an ebook. However, please consider buying this book as a reference during the course and in professional practice.*

ATTENDANCE POLICY / LATENESS / LATE WORK

Everytime you are absent or tardy, you miss valuable class time, activities, discussions, etc. Simply said, you will not get the most out of the course if you are not present.

Excused Absences

To receive an excused absence for illness, you need to email me before the class you will miss to let me know and bring in a doctor's note the following class day. If you are attending a field trip for another course, you need to bring me the field trip permission form at least one week before the trip. Otherwise, the absence will be unexcused. If you have other unexpected difficulties or family emergencies, contact me to discuss before the days you need to miss to discuss. Excused absences will not result in any grade penalties.

3 absences allowed

You are allowed 3 unexcused absences from class during the semester—no questions asked. If you are more than 15 minutes late for class, it will be considered an unexcused absence. The attendance policy is sufficiently flexible (1.5 weeks of class time) for you to make good decisions about when and when not to come into campus to attend class.

On the 4th absence

Be advised that on the 4th unexcused absence and for every unexcused absence after that, I will reduce your final grade in the course by a half grade (e.g., a B+ would become a B). I will not notify you of how many unexcused absences you have accrued before the grade penalty takes effect. However, you can email me to ask about your attendances to-date and to check your status. The GA may send out reminders to students approaching the 3-absence threshold. There are no exceptions to this attendance rule. The grade reductions will occur at the end of the semester before grades are submitted and not when they occur. As such, you will not see these grade reductions in the Canvas gradebook. I have had students in recent semesters fail the course due to too many unexcused absences. It is often surprising to students when they receive grade reductions at the end of the semester due to not keeping track of their class attendance during the semester. Do not let this happen to you!

Late Work

As described below under "Course Assessment," students are permitted to hand-in assignments and weekly responses up to one week late for a 25% reduction. No late work will be accepted after one week. Make-up exams will not be given without a doctor's note.

COURSE ASSESSMENT/GRADING

Grades in the course will be given based on the following percentages for course components:

Group Project (GP)	40 % (200 points total (points vary by submission))
Exams (EX)	30 % (150 points total (75 points ea.))
Weekly Assignment (WA)	20 % (100 points total (10 points ea.))
Attendance/Participation	10 % (50 points total (3.125 points per week))

**The total number of point available in the class is 500 points*

Grading Criteria: Multiple measures will be used to evaluate student performance in this course:

Group Project (GP): The group project is intended to facilitate the application of course materials to solve environmental systems specific problems and questions. Each submission will have a written description and instructions. There are 5 GP assignments over the course of the semester. See schedule for due dates.

This semester, the GP will consist of an applied design/analysis exercise using an architectural precedent to be completed in a small group of 3 people. For the group work portion of the assignments, all members of the group will receive the same number of points and you will hand in one copy of the submission as a PDF file upload to Canvas. The Instructor/GA will create groups in Canvas so that all members see the submission, grades, and comments.

GP submissions are generally due on Sunday evenings and will be accepted **up to 1 week late for a 25% penalty**.

Exams (EX): This class will have 2 exams over the course of the semester. Exams are taken on paper in class and will consist of 25 questions (mostly in multiple choice format). See schedule for exam dates.

Books and notes **may** be used during the exams. I recommend that you take good class notes and put tabs in your textbook for useful information. The Ball State Student Academic Ethics Policy (link below) clearly describes examples of "academic misconduct" during course assessments such as exams. You may not give assistance or information to another student. You may only use materials authorized by the instructor (no internet), and you may not copy another student's work or loan another student your study materials during the exam period.

Make-up exams will **ONLY** be given in the event of a verified emergency/illness that has been brought to the instructor's attention **BEFORE** the scheduled exam. Attendance at the final exam is mandatory. Do not make plans to leave campus for the break before the final exam period.

Final Exam Date/Time: Wednesday December 11th, 9-11am in our assigned classroom

Weekly Assignment (WA): In a course with a semester group project, it is important for you to have the opportunity individually to demonstrate understanding and mastery of skills and concepts we are learning about in class each week. The weekly assignments are meant to be brief, simple, regular individual tasks. You will submit your WA work to Canvas as a PDF file upload. On weeks where you have GP submissions or we have short class weeks, etc., there will be no WA submission. There will be 10 Was throughout the semester. See schedule for due dates.

WAs will be graded as follows check+ (full credit), check, and check- (half credit). Think of a "check" as an average/adequate submission that shows good understanding of the material, a "check-"as a submission that is incomplete, inadequate, or shows a lack of understanding of the material, and a "check+" as a submission that goes above and beyond and/or demonstrates excellent understanding of the material. Check = 7.5 points, Check+ = 10 points, Check- = 5 points. WA submissions are generally due on Sundays and will be accepted **up to 1 week late for a 25% penalty**.

Participation: Come to the in-person class on time, prepared, and ready to actively participate. Attendance will be taken at the beginning of class via a sign-in sheet. See me after class if you are late. Being late is better than not showing up at all and you will receive partial credit for coming. It is not acceptable to leave class early as this is distracting and disrespectful to me and to other students **UNLESS** we discuss it beforehand. Simply being in class is **NOT** the same thing as actively participating. If you come to class, never ask questions, never offer comments, reluctantly respond when called on, etc., your participation grade will suffer. To help prepare you for class, you will come to class with your notes from the assigned reading(s) and presentation due that day.

Bell Ringer Extra Credit: on class lecture days, I will often provide a question for you to answer before class gets started called a "bell ringer." The question will relate to something we have covered in class lecture and will often be a simple calculation or a speculative guess. You can work with a partner or individually. The first 5+/- students that get closest to the correct answer will get 1 extra credit point. These points can help you compensate for scores on exams, GPs, WAs, or attendance/participation. You will submit your answers on scraps of paper and bring them up to the front of class when you are done.

Grading Breakdown: Course grades in this course will not be curved, which tends to penalize those who do well. Final letter grades will follow Ball State's +/- grading scale (with 87.0—89.9 = B+; 83.0—86.9 = B; 80.0—82.9 = B- etc.). The overall semester course grade will be based upon a cumulative tabulation of the various course performance elements described above and weighted as indicated below:

COURSE EVALUATION

The instruction of the course is evaluated by departmental student evaluations and peer evaluation. The course is reviewed and revised periodically by the instructors and the Department Curriculum Committee. In-class time for students to complete semester evaluations will be provided.

CLASS TIME & LOCATION

Classroom: AB202
Class scheduled meeting times: MW 9:00-10:15am

TOPICAL COURSE SCHEDULE

Below is our tentative schedule. It may change during the semester to better suit our needs. Each week, we will cover specific topics and there will be course readings and online narrated presentations that you will have to complete BEFORE coming to class on your section day. The schedule also includes specific dates and assignments, WQs, RRs, or quizzes due. Note: this course includes a zero-energy design practicum experience as part of the DOE Zero Energy Design Curriculum pilot program.

WK	Topics Covered	Required Reading	Date	Due
01	Introduction, environmental resources: energy, water, emissions, energy modeling, energy metrics, energy grid, utility bills	Course Syllabus & Schedule, (MEEB) 37-64, PR 01, PR 02	Su 8/24	WA01
02	Thermal comfort & psychrometrics	(MEEB) 115-36, (TDA) 1-30, PR 03, PR 04	Su 8/31	WA02
03	Heat & heat flow, Thermodynamics, Fournier's Law, Envelope Design, Insulation **No Class M 9/01, Labor Day**	(MEEB) 277-322, PR 05	Su 9/7	GP01
04	Indoor Air Quality (IAQ)	(MEEB) 137-74, (SISS) Article PR 06	Su 9/14	WA03
05	Climate Control, Zoning, Heating, Cooling, & Ventilation **No Class W 9/17, Tom Away**	(MEEB) 531-63, (RW) 132-38, PR07	Su 9/21	WA04
06	HVAC Large/Small Bldgs, Air vs. Hydronic Systems	(MEEB) 564-84, (ASC) 223-41 (MEEB) 621-661, (ASC) 165-97 (GSH) 159-63 PR 08	Su 9/28	GP02
07	Electricity, Plug Loads, & Lighting	(MEEB) 1259-1373 PR09	Su10/05	WA05

WK	Topics Covered	Required Reading	Date	Due
08	Electric Light Sources, Light & Luminaires, Lighting technologies (e.g., LEDs), Electric Lighting Design **No Class M 10/6, Fall Break** **No Class W 10/8, Tom Away**	(WR) 138-43, (HLC) 434-48, (MEEB) 699-758 PR10	W 10/08	GP03.1
09	Exam Review	(MEEB) 759-811 PR11	W 10/15	EX01
10	**No Class 10/20 & 10/22, Field Trip Week**	None	None	None
11	Electric Lighting Design, Lighting Design Applications Luminaire Testing W 10/29 In class	(MEEB) 813-35, (ASC) 201-03, 244-46 PR12	W 10/29 Su 11/02	GP03.2 GP03.3
12	Luminaire Exhibit M 11/03 In-class Water Supply	(MEEB) 897-986 PR13	Su 11/09	WA06
13	Water Treatment	(MEEB) 1487-1562 (ASC) 207-209 PR14	Su 11/16	WA07
14	Mechanized Circulation; Fire Protection: Safety, Egress, Smoke Control, Suppression	(MEEB) 1179-1254, (ASC) 253-71 PR15	Su 11/23	GP04
15	Renewable Energy Sources, Solar PV, Solar Thermal, "duck curve" of overgeneration **No Class W 11/26, Thanksgiving Recess**	(MEEB) 1423-46, (MEEB) 935-48 (GSH) 235-247	Su 11/30	WA08/09
16	Sustainability/Green Design Operations/Performance Building Commissioning	(WE) 1, 11-15, (GSH) 18-23, (MA) 1-8 PR16, PR17	Su 12/07	WA10
17	Integrated Design **Last Class: M 12/08, W 12/10 EX02**	(GUY) 140-47	W 12/10 F 12/12	EX02 GP05

Schedule Key:

ASC: Allen, E., & Iano, J. (2017). *The architect's studio companion: rules of thumb for preliminary design*. John Wiley & Sons.

GSH: Kwok, A. G., & Grondzik, W. T. (2018). *The green studio handbook: environmental strategies for schematic design, 3rd edition*. Architectural Press.

GUY: Guy, S., & Farmer, G. (2001). Reinterpreting sustainable architecture: the place of technology. *Journal of Architectural Education*, *54*(3), 140-148. **(CA)**

HLC: Lechner, N. (2014). *Heating, cooling, lighting: sustainable design methods for architects*. John Wiley & sons.

Ebook Available: https://ebookcentral.proquest.com/lib/bsu-ebooks/detail.action?docID=1794558

MA: Malin, N. (2000). Building commissioning: the key to buildings that work. Building Green, 9(2), 1-8. **(CA)**

MEEB: Grondzik, W. T., & Kwok, A. G. (2015). *Mechanical and Electrical Equipment for Buildings*. John Wiley & Sons. (12th Edition)

SISS: Sisson, P. (2020). Your Old Radiator Is a Pandemic-Fighting Weapon. Bloomberg News.

TDA: Heschong, L. (1979). *Thermal delight in architecture*. MIT press.

WE: Wendt, A., Malin, N. (2010). Integrated Design Meets the Real World. Environmental Building News (EBN), 19(5). **(CA)**

RW: Rybczynski, W. (1986). *Home: A short history of an idea* (p. 203). New York: Viking. **(CA)**

EX: In-class Exam

WA: Weekly Assignment

GP: Group Project

PR: Narrated lecture presentation

CA: Uploaded to Canvas

Note: Schedule is subject to adjustment as appropriate throughout the course of the semester. Schedule and syllabus updates will be posted to Canvas and announced in class.

COURSE EVALUATION

The instruction of the course is evaluated by departmental student evaluations and peer evaluation. The course is reviewed and revised periodically by the instructors and the Department Curriculum Committee. In-class time for students to complete semester evaluations will be provided.

DIVERSITY STATEMENT

Ball State University aspires to be a university that attracts and retains a diverse faculty, staff, and student body. We are committed to ensuring that all members of the community are welcome, through valuing the various experiences and worldviews represented at Ball State and among those we serve. We promote a culture of respect and civil discourse as expressed in our Beneficence Pledge and through university resources found here. For Bias Incident Response information, please click here or e-mail ***mc2@bsu.edu***.

DISABILITY STATEMENT

*If you need course adaptations or accommodations because of a disability, please contact me as soon as possible. The **Office of Disability Services** coordinates services for students with disabilities; documentation of a disability needs to be on file in that office before any accommodations can be provided. Disability Services can be contacted at 765-285-5293 or **dsd@bsu.edu**.*

LEARNING CENTER

The Learning Center offers free Tutoring and Academic Coaching for many courses at Ball State. Students can make appointments for online (Zoom) or in-person (NQ 350) appointments. Unvaccinated students are required to wear masks and practice physical distancing in the Learning Center.
*To make an appointment, visit my.bsu.edu and click on "TutorTrac" in the Additional Tools section, or just go directly to **https://ballstate.go-redrock.com**.*

Testing accommodations for students with disabilities are available for students who have received the appropriate documentation from Disability Services. Tests may be administered in the Learning Center.

Supplemental Instruction is available in select courses. If you have an SI leader for your course, that person will provide students with information the first week of school regarding weekly study sessions.

For more information about all of our programming, visit ***bsu.edu/learningcenter*** *or call 765-285-1006. Follow us on Instagram: BallStateLC.*

WRITING CENTER

All writers improve with practice and feedback, so as a student in this course, you are encouraged to use the Writing Center (in Robert Bell 295, Bracken Library, or online) to get additional feedback on your writing. To schedule a free appointment to discuss your writing, go to **www.bsu.edu/writingcenter** Online and in-person appointments are available seven days a week: however, plan ahead because appointments book quickly!

COUNSELING AND HEALTH SERVICES

If you experience a mental health emergency, contact 911, your local police, or local hospital emergency room for support.

The Ball State University Counseling Center offers free and confidential services to all students. The Counseling Center is located in Lucina Hall, Room 320. To schedule an appointment, you can contact us at 765-285-1736. Ball State now also offers a 24/7 Crisis Line, which can be reached at 765-285-HOPE (4673). The Crisis Line is a mental health resource for those who are struggling with thoughts of suicide and/or self-harm or any other mental health concern.

At the Counseling Center, we provide therapy that is designed to help you address your concerns and feel better as quickly as possible. We see students for a variety of reasons, some of which include anxiety, depression, relationship concerns, and homesickness. At your first appointment, you will work with a therapist to create a plan that will connect you with the resources that best fit your needs. We assist clients with getting connected to therapeutic resources within our Center as well as self-help resources, other on-campus resources, and community-based resources. All Ball State students also have access to several on-demand self-help resources through a variety of different platforms. All of these resources, including a direct link to our website, can be found on the Counseling Center Linktree. To access our Linktree, use the following QR code:

https://www.bsu.edu/campuslife/counseling-center

STUDENT CONDUCT POLICIES

The **Code of Student Rights and Responsibilities** informs the community of the general behavioral expectations that the University has for all students and outlines the procedures that the University uses to respond to complaints when standards are violated. Students are expected to read, understand, and adhere to these community standards. https://www.bsu.edu/about/administrativeoffices/student-conduct

STUDENT ACADEMIC INTEGRITY POLICY

Students must comply with and are responsible for knowing the student academic ethics policy, as published in the Ball State University Student Handbook. Cheating on exams, plagiarizing papers, etc. will not be tolerated. University's Academic Integrity Policy:
https://www.bsu.edu/about/administrativeoffices/vice-provost/student-services/academic-integrity

Violations:
Examples of academic integrity violations include but are not limited to:

- Working with another person on any assignment other than authorized group projects.
- Sharing or allowing others to access your files, whether done with permission or not.
- Use or possession of a file created by someone else.
- Reusing work from another semester, course, or section.
- Fraudulent submission of work.
- Using unauthorized materials during Exams.
- Impersonating someone else or having them impersonate you.
- Making fraudulent or dishonest statements regarding your work.
- Soliciting others to complete work for you.
- Posting course files and resources on study or content sharing websites.

The Plagiarism Tutorial from UNC Libraries provides you with a great foundation in Academic Integrity. Plagiarism Detection: The campus subscribes to Vericite, a plagiarism prevention service, through Canvas. You may need to submit written assignments to Vericite. Student work will be used for plagiarism detection and for no other purpose. The student may indicate in writing to the instructor that he/she refuses to participate in the plagiarism detection process, in which case the instructor can use other electronic means to verify the originality of their work.

COPYRIGHT LAW

Students may not reproduce, distribute, or publicly post their course materials without faculty permission. Selling or distributing course materials may violate the Code of Student Conduct and/or the Information Technology Users' Privileges and Responsibilities policy. Violations will be referred to the Director of Student Rights and Community Standards

STUDENT TECHNOLOGY USE CONDUCT

Technology is an important part of contemporary architectural education and, as such, you will be using it inside and outside of class for projects and assignments. If you must accept an important phone call, please step out into the corridor to avoid disturbing classmates in the studio. Headphones must be used during class time if you choose to play music. In general, use technology in studio in ways that are respectful to your instructor, classmates, and guests and in ways that foster a healthy, friendly, and productive studio environment.

WORKPLACE COMPETENCIES

The National Association of Colleges & Employers (NACE) recommends that students develop these competencies.
https://www.naceweb.org/uploadedfiles/files/2021/resources/nace-career-readiness-competencies-revised-apr-2021.pdf

- Career & Self Development: Proactively develop oneself and one's career through continual personal and professional learning, awareness of one's strengths and weaknesses, navigation of career opportunities, and networking to build relationships within and without one's organization.

- Communication: Clearly and effectively exchange information, ideas, facts, and perspectives with persons inside and outside of an organization.

- Critical Thinking: Identify and respond to needs based upon an understanding of situational context and logical analysis of relevant information.

- Equity & Inclusion: Demonstrate the awareness, attitude, knowledge, and skills required to equitably engage and include people from different local and global cultures. Engage in anti-racist practices that actively challenge the systems, structures, and policies of racism.

- Leadership: Recognize and capitalize on personal and team strengths to achieve organizational goals.

- Professionalism: Knowing work environments differ greatly, understand and demonstrate effective work habits, and act in the interest of the larger community and workplace.

- Teamwork: Build and maintain collaborative relationships to work effectively toward common goals, while appreciating diverse viewpoints and shared responsibilities.

- Technology: Understand and leverage technologies ethically to enhance efficiencies, complete tasks, and accomplish goals.

ACCREDITATION CRITERIA

This course satisfies criteria established by the National Association of Architectural Accrediting Boards (NAAB) as part of the program accreditation.
https://www.naab.org/wp-content/uploads/2020-NAAB-Conditions-for-Accreditation.pdf

Program Criteria (PCs)

- PC.3 Ecological Knowledge and Responsibility—How the program instills in students a holistic understanding of the dynamic between built and natural environments, enabling future architects to mitigate climate change responsibly by leveraging ecological, advanced building performance, adaptation, and resilience principles in their work and advocacy activities.
- PC.5 Research and Innovation—How the program prepares students to engage and participate in architectural research to test and evaluate innovations in the field.

Student Criteria (SCs)

- SC.1 Health, Safety, and Welfare in the Built Environment *(Understanding)* —How the program ensures that students understand the impact of the built environment on human health, safety, and welfare at multiple scales, from buildings to cities.
- SC.4 Technical Knowledge—How the program ensures that students understand the established and emerging systems, technologies, and assemblies of building construction, and the methods and criteria architects use to assess those technologies against the design, economics, and performance objectives of projects.
- SC.6 Building Integration *(Ability)* —How the program ensures that students develop the ability to make design decisions within architectural projects while demonstrating integration of building envelope systems and assemblies, structural systems, environmental control systems, life safety systems, and the measurable outcomes of building performance (assessment by NAAB of all passing student work is part of the assessment)