

**ARC 230**  
**ENVIRONMENTAL SYSTEMS**

**COURSE DESCRIPTIONS:**

Prerequisites: ARC 111 and MAT 121

Corequisites: None

This course introduces plumbing, mechanical (HVAC), and electrical systems for the architectural environment. Topics include basic plumbing, mechanical, and electrical systems for residential and/or commercial buildings with an introduction to selected code requirements. Upon completion, students should be able to develop schematic drawings for plumbing, mechanical, and electrical systems and perform related calculations. Course Hours per Week: Class, 3. Lab, 3. Semester Hours Credit, 4.

**LEARNING OUTCOMES:**

A student who successfully completes this course should be able to:

- a. Calculate U-values for various building components
- b. Calculate Total Heat Loss and Heat Gain for a building (using manual J or selected software)
- c. Perform a temperature gradient calculation
- d. Calculate the cost of heating
- e. Determine the size of duct work, tonnage of heating plant
- f. Perform calculations using the Psychometric chart
- g. Understand the basic operation of HVAC equipment, plumbing & piping systems & electrical distribution systems
- h. Understand protection systems
- i. Draw a riser diagram

**OUTLINE OF INSTRUCTION:**

- I. Course overview; Energy and Environment
  - A. Climate and the site
    - 1) Microclimates
    - 2) Direct sun, daylight and sun charts
    - 3) Ventilation and cooling
- II. Energy and Architectural Design
  - A. The building envelope and its components
  - B. Envelopes and energy leakage
- III. Environmental Planning
  - A. Passive solar planning

- B. Natural day lighting and heating
  - C. Windowless buildings
- IV. Climate Control Systems
- A. Exterior ducting
  - B. Downfeed air distribution
  - C. Electrical systems
- V. Energy Conservation
- A. Heat pumps
  - B. Solar assisted heat pumps
- VI. Heat Loss and Heat Gain
- A. Regulation of the thermal environment
  - B. Comfort and metabolism
  - C. Criteria for thermal comfort
    - 1) Design conditions
    - 2) ASHRAE Comfort Standard (55-74)
- VII. Nature of Heat Flow
- A. Homogenous solids and conductivity
  - B. Air spaces and emittance
  - C. Effects of air motion
- VIII. Overall co-efficient of heat transmission
- A. Conductivity (K)
  - B. Conductance ©
  - C. Emissivity (E)
  - D. Thermal Resistance (R)
- IX. Heat loss computations
- A. Thermal resistance of plane air spaces
  - B. Surface conductance and resistance for air
  - C. Thermal properties of typical building and insulating materials
  - D. U-value resulting from adding insulation
  - E. Concrete slabs
  - F. Windows, skylights and light transmitting partitions
  - G. Doors
  - H. Air Infiltration and air changes
  - I. Attics, basements and crawl spaces
  - J. Heat transfer factors
- X. Energy Code Calculations
- A. Purpose
  - B. Format
  - C. Procedure

- XI. Heat Gain Computations
  - A. Residential heat gain factors
  
- XII. Water and drainage systems and applications
  - A. Water recycling
    - 1) Kinds of water
    - 2) Water supply
    - 3) City
    - 4) Wells
  
  - B. Water Systems
    - 1) Water distribution
    - 2) High Rise
    - 3) Community and private
    - 4) Hot water distribution
    - 5) Conservation
  
  - C. Plumbing Systems -- Supply
    - 1) Hot water
    - 2) Cold water
    - 3) Shock – relief
  
  - D. Drainage
    - 1) Vents
    - 2) Traps
    - 3) Waste lines
    - 4) Soil stacks
    - 5) Clean out
  
  - E. Water Heaters
    - 1) Energy Type
    - 2) Sizing
  
  - F. Private Disposal System
    - 1) Tank
    - 2) Distribution box
    - 3) Field lines
  
  - G. Storm Water Systems
    - 1) Background and historical implications
    - 2) Storm water disposal
    - 3) Gutters and leaders
  
  - H. Plumbing plans
    - 1) Fixtures
    - 2) Cold water supply
    - 3) Hot water supply
    - 4) House drain
    - 5) Layout of soil lines
    - 6) Location cleanout

- 7) Vents and stacks
- 8) Gas lines
- 9) Riser diagrams

I. Electrical systems and system components

- 1) National Electric Code
- 2) Amperage
- 3) Circuits
- 4) Breakers
- 5) Conductors
- 6) Ground
- 7) Outlet
- 8) Receptacle
- 9) Service entrance
- 10) Service panel
- 11) Low voltage switching
- 12) Fixtures

J. Drawing Electrical Plan

- 1) Location of panel
- 2) Outlet symbols
- 3) Switching arrangements
- 4) Fixture locations

K. Protection Systems

- 1) Fire Alarms

XIII. Basic Lighting

A. Lighting Terms, Principles & Symbols

- 1) Reflectance, Contrast, Glare, Illuminance

B. Light Sources

- 1) Dimmed
- 2) Switching
- 3) Halogen
- 4) Incandescent
- 5) Florescent

C. Light Schemes

- 1) Task lighting Vs. Area lighting
- 2) Factors affecting difficulty of lighting task
- 3) Organization of lights around a task to prevent glare

D. Light Calculations

- 1) Zonal cavity method
- 2) Ceiling cavity method
- 3) Floor cavity method
- 4) Maintenance factors
- 5) Auxillary equipment