

# Course Syllabus

## Columbia University

School of Architecture, Planning and Preservation

A46SUSTAINABLE DESIGN (GSAPP) – FALL 2019

*Course number:* ARCH A4684\_001

*Time:* Friday, 11:00 – 13:00

*Room (verify):* TBD

*Instructor:* Davidson Norris - Davidson Norris Architect & Carpenter  
Norris Consulting

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### DESCRIPTION:

Sustainable Design recognizes that the architect's primary challenge is the poetic integration and inspired balancing of multiple technical, and sometimes conflicting, sustainable options. To address this, the course introduces the student to the core technical principles that govern sustainable design and, in parallel, requires their inspired and poetic application to the design of a three storey classroom block, part of the High School for Environmental Science (HSES).

In a series of weekly lectures the instructor will present core principles and practices of sustainable design. See below for specifics. Lecture slides will be posted before each class on Courseworks. A bibliography of back-up readings will also be posted, with many selections available on reserve in the Library.

The semester will focus effort on a sketch design problem. The design problem will require the successive application of sustainable techniques and technologies, described in the weekly lectures, to the design of a classroom block with 9 classrooms plus circulation and simple services. Acting as your sustainable design guide and consultant, the instructor will review and comment weekly on the student's developing design. The final integrated sustainable design will be presented for review at the end of the semester.

While the program for the HSES will be identical, the student will have the option of developing it in one of 4 different climate types (cool, temperate, hot/wet or hot/dry). In all climate cases the site and context (urban) will be the same – Central Park in New York City.

### CLASS ASSIGNMENTS & FINAL PROJECT:

1. Development and presentation of case study highlighting sustainable design.
2. Weekly sketch design application of that week's sustainable strategy to your HSES design. See below.
3. Final project: HSES presentation.

## TEXTBOOKS

While there are no required texts books for the course I highly recommend that you purchase Sun, Wind & Light, Architectural Design Strategies, latest edition, Brown, G. and DeKay, M., Wiley. Written by architects for architects, it outlines sustainable strategies, techniques and technologies, provides helpful sizing graphs and charts, and offers many excellent examples of their architectural application. It is the basis for much of my instruction and should be a foundation document in your sustainable design library.

## SOFTWARE

Over the course of the semester, we will rely on a number of softwares. All are downloadable from the internet:

PMV Tool – CBE Thermal Comfort Tool for ASHRAE-55 (<http://comfort.cbe.berkeley.edu>)

Climate Consultant (<http://www.energy-design-tools.aud.ucla.edu/climate-consultant/request-climate-consultant.php>)

Façade Design Tool (<http://www.commercialwindows.org/fdt.php> (Links to an external site.))

Energy analysis - SEFAIRA (<http://sefaira.com> (Links to an external site.))

Sefaira is not public domain but is available free of charge for our class. You will be given a temporary license. To use Sefaira your model will have to be developed in Sketchup, available for \$45 for students. Using a simple SketchUp model with the Sefaira plug-in on your own computer, Sefaira allows you to test and compare preliminary sustainable design strategies using a calculation of the design's EUI (Energy Use Index). It can also analyze the design's daylighting performance.

## CLASS & ASSIGNMENT SCHEDULE

### 09.06 **1. The sustainable building argument**

- - - Energy, economic, productivity and architectural rationales
    - Case study: the Bullitt Center, Seattle

*Assignment: case study*

09.13 **2.Sustainable building fundamentals**

- - - Personal thermal comfort and psychrometrics
    - Sun/earth relationship
    - Microclimatic variables
    - Urban heat island
    - Introduction to CRE psychrometric tool

*Assignment: productivity optimization exercise using psychrometrics*

09.20 **3. Sustainable building psychrometrics and internal gains**

- - - Building psychrometrics
    - Climate zones
    - Introduction to Climate Consultant (CC)
    - Evaluating sustainable design strategies based on thermal comfort
    - Internal heat gains

*Assignment: HSES climate analysis using Climate Consultant*

09.27 **4. Sustainable site strategies**

- - - Siting sustainable priorities
    - Sun mask and obstruction mapping
    - Solar access using Andrew Marsh sun mask tool
    - Solar access and site topography
    - Site wind mapping using Climate Consultant
    - Applied sustainable site selection

*Assignment: HSES site analysis and selection*

10.04 **5. Sustainable building cluster**

- - - Building cluster design in different climates
    - Solar spacing between buildings with Andrew Marsh Solar Access tool
    - Solar access using Andrew Marsh sun mask tool
    - Cluster design for wind inclusion and exclusion

- Cluster design for daylight access

*Assignment: HSES site cluster design*

#### 10.11 6. **Sustainable Building Design – envelope strategies**

- - - Building orientation as response to sun and wind
    - Building aspect ratio as response to local climate
    - Sustainable programming and space distribution
    - Envelope heat loss and gains
    - Envelope insulation
    - Envelope glazing and window to wall ratio
    - Envelope infiltration prevention
    - Building scale energy impacts of envelope strategies

*Assignment: HSES classblock schematic design (Sefaira)*

#### 10.18 7. **Sustainable Building Design- active and passive solar heating**

- - - Active solar water and space heating
    - Passive direct gain
    - Passive trombe wall
    - Passive sunspace
    - Photovoltaic (PV) electricity

*Assignment: Apply solar heating and PV systems to HSES classblock (Sefaira)*

#### 10.25 8. **Sustainable Building Design – passive cooling**

- - - Earth tempering
    - Mass tempering
    - Shading
    - Albedo (surface reflectance)
    - Natural ventilation

*Assignment: Apply passive cooling to HSES classblock (Sefaira)*

#### 11.01 9. **Sustainable Building Design - daylight**

- -

- Lighting power density
- Efficient electric lighting (lamp and fixture)
- Daylighting factor analysis with Marsh DF tool
- Glazing selection using LBNL windows tool.
- Daylight, visual comfort and glare
- Advanced daylighting analysis using Sefaira

*Assignment: Apply daylighting to HSES classblock (Sefaira)*

## 11.08 **10. Sustainable waste and water management**

- - - Water conservation targets and solutions
    - Waterless waste solutions
    - Greywater and blackwater management
    - Site and building storm water collection and management
    - On site waste treatment

*Assignment: HSES classblock waste and water plan*

## 11.15 **12. Sustainable Building Design – mechanical systems**

- - - District heating
    - On site electric generation
    - Advanced boilers
    - Alternate fuels – wood chips
    - Heat pumps
    - Gas fired chillers
    - Ice cooling
    - Heat recovery
    - Chilled beam heating and cooling
    - 6 surface radiant heating and cooling

*Assignment: HSES design integration and development of Sefaira model*

11.22 THANKSGIVING

12.06 **No class – review week**

12.09 **Individual final project review with DN**

12.13 **Final submission on Courseworks**

*To include sustainable narrative, site plan, plan and section(s), sustainable systems diagram, 3d digital model, Sefaira energy analysis of base and EC building designs, including daylighting.*