

### **Spectrum Session 2**

#### **Course Title:** Architecture: A Study in Math & Physics Honors

#### **Course Description**

This class will cover the connections between math, science, and architecture. We will be studying various types of bridges and towers and the basics of residential construction. We will learn the scientific principles that allow these structures to stand up to the stresses that they are subjected to, and will explore the relationships between math, science, and architecture through researching, drawing, and scale model building. The course will also include testing of bridge and tower models for structural soundness and efficiency, based on standard competition guidelines.

#### **Essential Questions**

- What are the various loads a structure must withstand and how are they able to do so?
- How does the choice of a structural system reflect itself in the aesthetics of a building?
- What criteria do engineers and architects use to determine if a structural system is successful?

#### **Outcomes**

Upon successful completion of this course, students will:

- Be familiar with the scientific principles that enable various structures to support loads. These scientific principles include but are not limited to compression, tension, shear and loading.
- Know how to calculate structural efficiency.
- Know how to calculate the attributes of building materials and understand how their use relates to structural efficiency.
- Learn and identify the different elements and materials which are used to build.
- Design, build, and test their own towers and bridges.
- Have an understanding of the basic elements and functions of residential construction.

#### **Instructional Strategies**

Students will work individually and in pairs. They will have the ability to demonstrate their individual understanding of mathematical and scientific concepts on a test. They will also be able to demonstrate their individual creativity through various sketches and designs on their bridges and towers. They will be responsible for showing their leadership and cooperation on a daily basis when working with partners or teams while they design and construct their structures.

#### **Resources and Materials**

- **Books**
  - Francis D. K. Ching, Building Construction Illustrated, 4<sup>th</sup> ed. 2008, ISBN #978-0-470-08781-7 (pbk)
- **DVDs**
  - Nova: Building the Great Cathedrals DVD, Amazon ASIN #B003WKQ44Q
  - David Macaulay: Building Big: Bridges DVD, Amazon ASIN #B0002XVSD1
  - David Macaulay: Building Big: Skyscrapers DVD, Amazon ASIN #B0002XVSF6

#### **Materials**

- A course pack will be provided. The information from this packet comes from a variety of sources. These include:

- 1) *The Art of Construction, Chicago Press Review*, written by Mario Salvadori.
  - 2) *Building Big, Houghton Mifflin Company*, written by David Macaulay.
  - 3) *Science Olympiad Rules*
  - 4) *Pitsco Bridge Building*
- b. Other Materials: Students will also be responsible for bringing a BASIC calculator and a journal to class each day. All other materials will be supplied by the instructor.

## Student Assessment

### Pre-Assessment

The pre-assessment will be comprised of two parts. The first part will be a written and mathematical assessment that asks the students about scientific principles and mathematical concepts. The second component will be a quiz of relevant vocabulary terms and their definitions.

### Documentation of Learning

Students will be asked to keep a journal with notes, thoughts and sketches made throughout the course. They will research construction methods and materials used in the construction of bridges and towers and will use this knowledge to build two models of each with balsa wood which will be judged for strength, craftsmanship, creativity and understanding of the concepts they have studied. They will also study the basics of residential construction through observation, lecture, reading and drawing which will result in a final sketch problem which will assess their understanding.

### CTD Grading Scale

A+	100-97%	A	96-93%	A-	92-90%
B+	89-87%	B	86-83%	B-	82-80%
C+	79-77%	C	76-73%	C-	72-70%
D+	69-67%	D	66-63%	D-	62-60%
F	below 60%				

### Breakdown of Final Grade

The final grade will be determined from a combination of:

- a. A final test that will cover the scientific principles and math concepts. (25%)
- b. The student's journal which will also include all of their drawings. (25%)
- c. Progress and participation in the construction of the structures. (20%)
- d. The efficiency of the bridge structure. This will be based on a rubric that will be provided to each student. (10% for each structure)
- e. The efficiency of the tower structure. This will be based on a rubric that will be provided to each student. (10% for each structure)
- f. A quiz covering the residential construction materials (10%)

### Post-Assessment

A final post-assessment test will be given on the last day of the course which will cover the same topics as the pre-assessment test, as well as specific topics taken from the course materials and activities.

## Schedule

Date(s)	Topic(s)	In-class Activities	Graded Assignments and/or Assessment
<b>Week 1</b>			
Monday, July 18	Introductions: both to each other and to the course. Thinking creatively and as part of a group.	<ul style="list-style-type: none"> <li>-Go over class and CTD rules.</li> <li>-Ice breaker activity.</li> <li>Brainstorming exercise</li> <li>- Written Pre-Test.</li> <li>DVD: Great Cathedrals followed by lecture: Intro to Structural Issues</li> </ul>	Journal entries on ice breaker puzzler and brainstorming exercise.
Tuesday, July 19	<ul style="list-style-type: none"> <li>- Learn about the different types of bridges.</li> <li>- Learn about the forces involved that affect bridges.</li> <li>- Structural efficiency.</li> <li>- Assign groups.</li> </ul>	<ul style="list-style-type: none"> <li>-Warm-up puzzler</li> <li>-Handout bridge packets followed by in-class reading and discussion</li> <li>Break into pairs.</li> <li>- Apply what was learned to sketch possible bridge designs.</li> </ul>	<ul style="list-style-type: none"> <li>- Read the bridges portion of the packet and answer attached questions to be handed in.</li> <li>- Update your journal with the bridge sketches, and notes regarding final selection and construction methods to be used.</li> </ul>
Wednesday, July 20	<ul style="list-style-type: none"> <li>- Introduce the specific construction rules for building the bridges.</li> <li>-Calculate loads for various conditions.</li> <li>- Calculate slope.</li> <li>-Calculate Pythagorean Theorem.</li> </ul>	<ul style="list-style-type: none"> <li>-Warm-up puzzler</li> <li>-Individually sketch at least 3 designs of bridges that meet the criteria of the rules.</li> <li>- In your assigned groups, share designs and decide which one to build.</li> <li>- Draw and start construction of the test bridge design to scale.</li> </ul>	<ul style="list-style-type: none"> <li>-Journal entries that include your sketches and calculations.</li> <li>-Complete geometry problem set.</li> </ul>
Thursday, July 21	<ul style="list-style-type: none"> <li>Bridge construction and testing</li> <li>Critical thinking and responses.</li> <li>Synthesis of ideas.</li> </ul>	<ul style="list-style-type: none"> <li>-Warm-up puzzler</li> <li>-Finish test bridges and test for strength.</li> <li>-In class critique of bridge designs</li> <li>- Watch Bridge DVD</li> <li>-Begin construction of final bridge based on testing and critiques</li> </ul>	<ul style="list-style-type: none"> <li>Update your journals with notes on testing observations and possible responses.</li> <li>Write a response to bridges seen in DVD</li> </ul>
Friday, July 22	-Final bridge construction and testing	<ul style="list-style-type: none"> <li>- warm-up puzzler</li> <li>- Finish final bridge construction followed by final testing and evaluation</li> </ul>	<ul style="list-style-type: none"> <li>Journal entries.</li> <li>Structural efficiencies of the bridges.</li> <li>Self-assessments.</li> </ul>

Date(s)	Topic(s)	In-class Activities	Graded Assignments and/or Assessment
<b>Week 2</b>			
Monday, July 25	Bridge and towers in person. Visiting engineer's and architects' offices	-Field trip to the Loop to see various bridges, buildings, and professional offices	-Update your journal with field notes and sketches.
Tuesday, July 26	<ul style="list-style-type: none"> <li>- Learn about the different types of towers.</li> <li>- Learn about the forces involved that affect towers.</li> <li>- Reassign groups.</li> </ul>	<ul style="list-style-type: none"> <li>-Warm-up puzzler</li> <li>-Handout tower packets followed by in-class reading and discussion</li> <li>- Apply what was learned to sketch possible tower designs.</li> </ul>	<ul style="list-style-type: none"> <li>-Update your journal.</li> <li>Compose answers to questions accompanying tower reading material</li> </ul>
Wednesday, July 27	<ul style="list-style-type: none"> <li>- Introduce the specific construction rules for building the towers.</li> <li>-Calculate loads for various conditions.</li> <li>- Calculate wind loads.</li> </ul>	<ul style="list-style-type: none"> <li>-Warm-up puzzler</li> <li>-Individually sketch at least 3 designs of bridges that meet the criteria of the rules.</li> <li>- In your assigned groups, share designs and decide which one to build.</li> <li>- Draw the first tower design using all specific measurements to scale.</li> <li>Start construction on test towers.</li> </ul>	<ul style="list-style-type: none"> <li>-Update your journal</li> <li>Complete physics problem set.</li> </ul>
Thursday, July 28	<p>Tower construction and testing</p> <p>Critical thinking and responses.</p> <p>Synthesis of ideas</p>	<ul style="list-style-type: none"> <li>-warm-up puzzler</li> <li>-Finish test towers and test for strength.</li> <li>-In class critique of tower designs</li> <li>- Watch Skyscrapers DVD</li> <li>-Begin construction of final tower based on testing and critiques</li> </ul>	<ul style="list-style-type: none"> <li>-Update your journals with notes on testing observations and possible responses</li> <li>Write review of DVD</li> </ul>
Friday, July 29	-Final tower construction and testing	<ul style="list-style-type: none"> <li>- warm-up puzzler</li> <li>-Finish final tower construction followed by final testing and evaluation</li> </ul>	<ul style="list-style-type: none"> <li>Journal entries.</li> <li>Structural efficiencies of the towers.</li> <li>Self-assessments.</li> </ul>

Date(s)	Topic(s)	In-class Activities	Graded Assignments and/or Assessment
<b>Week 3</b>			
Monday, August 1	<p>Introduction to residential architecture.</p> <p>The names and purposes of the many elements.</p> <p>Calculating areas, heights, and using an architectural scale.</p>	<p>-warm-up puzzler</p> <p>-in-class lecture/discussion</p> <p>- assigned reading</p> <p>- sketching to scale: drawing a plan</p> <p>-presentation of plans</p>	<p>-Update your journal.</p> <p>Draw the plan of your dorm room.</p>
Tuesday, August 2	Visiting houses.	<p>- Walking field trip in Evanston to learn the anatomy of houses, including a construction project (if possible) to see structural and mechanical elements in place.</p>	-Update your journal with field notes and sketches.
Wednesday, August 3	<p>Designing a structural system.</p> <p>Reading span charts.</p> <p>Calculating loads</p>	<p>-warm-up puzzler</p> <p>-Using a common plan provided by the teacher, and info in the Ching book, design and draw a method for framing a house.</p>	<p>-Update your journal.</p> <p>Read chapters in Ching related to framing and complete set using span charts provided.</p>
Thursday, August 4	<p>Designing the mechanical systems for a house.</p> <p>Learning the science and math involved in plumbing, heating, and electrical systems.</p>	<p>-warm-up puzzler</p> <p>-Continue with the same plan and add diagrams of all mechanical elements.</p> <p>Quiz covering residential topics.</p>	<p>-Update your journal.</p> <p>Read chapters in Ching related to mechanical systems and complete problem set provided.</p> <p>- Quiz scores.</p>
Friday, August 5		<p>- Post assessment test followed by presentation of bridge, tower and house plan photos and drawings at Expo.</p>	-Final test scores.

### CTD Statement on Third-Party Web Sites

Instructors are required to thoroughly review any third-party web sites they intend to use in their courses for inappropriate content. However, because web content continuously changes, CTD disclaims any responsibility for any of the content contained on third-party web sites used in course materials. If you become aware of anything that may be inappropriate, please notify CTD staff immediately.