Questions 1-10 are worth 2 points each, with no partial credit given. Please indicate the best possible answer in each case.

1. Arches that come to a point at the peak are referred to as
   A) Catenary
   B) Jack
   C) Gothic
   D) Roman
   E) Segmental

2. Balloon frames
   A) are an example of a double cable suspension structure
   B) are an example of a double curvature suspension structure
   D) are relatively safe in the event of fire
   C) use studs that rise the entire height of a house
   E) None of the above

3. Who built the Kauffman House, popularly known as Falling Water?
   A) Buckminster Fuller
   B) I.M. Pei
   C) John A. Roebling
   D) Joseph B. Strauss
   E) Frank Lloyd Wright
4. The figures display 4 funicular systems, two arches and two suspension cables. Assuming the total weight supported is the same in each case, which shape experiences the greatest horizontal force at the endpoint?

A) All of these will have the same horizontal force.

5. A lintel is
   A) a short beam
   B) a column integrated into a bearing wall
   C) a repeated element in a large framed structure
   D) a shaped stone used for an arch
   E) a half-arch used to support a bearing wall

6. A pilaster is
   A) a short beam
   B) a column integrated into a bearing wall
   C) a repeated element in a large framed structure
   D) the top piece that holds an arch together
   E) a small piece that prevents shear slippage between layers of a beam
7. A voussoir is
   A) a half-arch used to support a bearing wall
   B) a repeated element in a large framed structure
   C) a shaped stone used for an arch
   D) a small piece that prevents shear slippage between layers of a beam
   E) the top piece that holds an arch together

8. Comparing a series of simply supported beams to a single continuous beam (made of the same materials and cross-section), and we find that
   A) the continuous beam has a longer effective span
   B) the continuous beam will experience more sag
   C) the continuous beam will experience less sag
   D) the continuous beam will experience the same sag
   E) Both A and B

9. Which statement about catenary cables is correct?
   A) A catenary cable with a low sag will have a large horizontal pull and a thick cable.
   B) A catenary cable with a deep sag will have large horizontal pull and a thick cable.
   C) A catenary cable with a low sag will have a small horizontal pull and a thick cable.
   D) A catenary cable with a deep sag will have a small horizontal pull and a thick cable.
   E) None of the above

10. Consider a foam beam 10 feet long, 3” wide, and 6” deep. When placed on its 6” side, it deflects 4” under a load. If placed on its 3” side instead, it will deflect
    A) 1”
    B) 2”
    C) 4”
    D) 8”
    E) 16”
Questions 11-16 are worth 5 points each, with partial credit given. Answer each question with a short paragraph or list. You may include equations or drawings if it aids your explanation.

11. Explain why concrete slabs must be reinforced with steel bars. Describe the difference between prestressed and posttensioned beams.

12. Suppose you want to suspend a heavy weight from the end of a horizontal cantilever. In order to minimize the amount of material needed, what is the optimum shape for the cantilever (i.e. the shape that provides greatest strength for least material)? Describe and draw BOTH the longitudinal shape (i.e. side view) and the cross-section (end view).
13 The rectangle below represents a large warehouse. If you could use only 15 columns to support this structure, where would you place them (Draw the dots in the figure, then explain your reasoning.)

14. Define a funicular system and a catenary cable.
15. Describe how a masonry arch is constructed.

16. (Note: the table below gives the modulus of elasticity for some building materials.) A supported steel beam 10’ long sags 2” under a load. A titanium beam (of the same cross section, and also simply supported) sags 2” under the same load. How long is the titanium beam?

<table>
<thead>
<tr>
<th>Modulus of Elasticity (E)</th>
<th></th>
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<tbody>
<tr>
<td>Steel</td>
<td>30 million psi</td>
</tr>
<tr>
<td>Titanium</td>
<td>15 million psi</td>
</tr>
<tr>
<td>Aluminum</td>
<td>10 million psi</td>
</tr>
<tr>
<td>Soft Timber</td>
<td>2 million psi</td>
</tr>
</tbody>
</table>
Other possibilities: maybe for final…

What is the longest distance achieved to date between the main span supports of a suspension bridge?

(Why?) are 2D versions of a structural element (bearing wall, vault) more sturdy than a series of their 1D counterparts (column, arch)?

9. What is longest clear span achieved to date with a suspension bridge?
A) 210 feet
B) 1268 feet
C) 4200 feet
D) 6529 feet
E) 10,523 feet