ARCH 631. Essay Questions for Exam 1

This is the list of possible essay questions* for Exam 1.

*Only one question will be asked on the exam.

1. The process of structural design must consider the environmental loads, the design codes and design methods, the material, the overall stability of the assembly, the arrangement and interconnectivity of the assembled elements, and the strength and stiffness of the elements. Using an arch for an example, describe the major design steps for an arch within the context of the types of loads, arrangement of loads which must be considered, supports, how the loads are quantified, what material is appropriate, how the member forces, stresses, and displacements are determined and the methodology to evaluate them, and how the member sizes or cross section are determined for a valid design. Make certain to sketch your arch with the supports and expected loads and possible deformations which must be considered, and put notes (annotate) with arrows on your sketch.

2. Arches and beams are both considered rigid line-forming structural elements by classification, but have distinctly unique geometry and structural behavior. Discuss the similarities of the behavior and design of arches and beams with loads and load types, supports, lateral behavior, effect of (non-support) hinges, stresses, appropriate materials, system shape and member shaping, and deflection. Choose one beam system with loads (other than a simply supported beam under uniformly distributed load), and one arch system and loads and draw a diagram of each. Annotate the specific differences between the behavior and design of the systems you have chosen with notes and arrows to the related locations on the figures.

3. Design of cable systems follows the general design process of defining geometry and member hierarchies, assessing loads, selecting a methodology, modeling of the structure and loads, analysis of the structure, and evaluation with respect to structural criteria. Describe the specific design process for cable systems while considering behavior, materials, and span. Identify the benefits of a double cable system over a single cable system. Draw and annotate all key parts (with notes and arrows) for a double cable roof system (either 2D or 3D), and draw and annotate all key parts for a possible truss form that could be used. Include the location and direction of support forces in both sketches.

4. Funicularly shaped trusses, like bowstring and lenticular ones, are often compared to arch and cable structures to explain the nature of the forces in the members. Describe the properties of a funicular structure with respect to the material, cross section, shape, member lengths, system height and span, support conditions and common loadings. Draw a funicularly shaped truss with loading and annotation (notes and arrows) to illustrate your description. Identify the advantage of this truss shape with respect to a parallel chord truss. Identify the major design concern when the loading conditions change. Also discuss why it is unusual for beams to be funicularly shaped.

5. Trusses and arches have the common characteristic that they must resist normal stresses and compression, in particular. Describe the design requirements and considerations for trusses and those for arches, particularly with respect to the material, cross section shape, length, height or span, support conditions, and common loadings. Identify solutions for the design requirements that are similar, and also identify the solutions that are unique to each component type. Draw an efficiently shaped truss *or* arch (only one) with the appropriate loading (size and location) and annotation (notes and arrows), and explain how it is efficient. Also discuss any buckling potential for your system choice, and illustrate and annotate (with notes and arrows) how it would be prevented from buckling on your drawing.

6. Columns and arches have the common characteristic that they must resist compressive forces and not buckle. Describe the design requirements and considerations for columns and for arches with respect to the material, cross section shape, length, height or span, support conditions, and common loading types and distribution. Identify solutions for the design requirements that are similar, and also identify those that are unique to each component type. Draw a slender column having a cross section other than a wide flange steel shape, rectangular (timber) shape, or circular shape, and discuss the need for bracing for your shape and add it on the figure with notes and arrows. Describe the buckling modes and illustrate them on the figure (with notes and arrows).

7. Cables, trusses and arches have the unique characteristic that they can be structurally efficient. Describe each system and how the system is or can be constructed in order to be structurally efficient with respect to shape or arrangement, quantity of material, loads or stresses, cross section geometry, material selection, and serviceability. Draw an arch with an unusual loading (*not* a uniformly distributed load) and describe how the profile or section could be customized to respond to that loading. Include annotations (notes and arrows) on your drawings. Identify the support conditions and any other requirements to satisfy serviceability.

8. Trusses are one of the most popular structural assemblies for large spans and have the most variety of configurations. Describe the advantages of trusses for long spans, and the design requirements for strength and serviceability with respect to the overall shaping, member orientations, and specific loading conditions. Use a truss style other than a parallel chord truss with a typical load arrangement to specifically show the anticipated forces that must be resisted at a section with an annotated drawing. Also illustrate and describe the effect of changing the orientation of the diagonal members to connect to the opposite corners of the four sided shape with annotations (notes and arrows.)

9. Cable systems have to contend with potential problems caused by the dynamic nature of wind. Describe the problem using appropriate vocabulary, and describe the structural arrangement, design requirements, and analysis methods for suspended systems, double-cable systems, and cable stayed structures. Draw an example for each system type and discuss the typical solutions with respect to behavior, configuration, sizing, pretensioning, and location of system members. Include annotations (notes and arrows) on your drawings. Identify the support conditions and any other requirements to satisfy serviceability.