Each of the following questions is worth 2 points each.

1. The slump of grout is to be between:
   A. 4-6 inches
   B. 6-8 inches
   C. 8-11 inches
   - C. 8-11 inches

2. Define head joint:
   Vertical joint between masonry units

3. Which has more Portland cement, Type S mortar or Type N mortar?
   Type S

4. What are the actual dimensions of a 12” concrete masonry unit?
   11-5/8 inch thick; 7-5/8 inch high; 15-5/8 inch long

5. Describe what is meant by a partially grouted wall.
   Grout is only in some cells, usually those containing reinforcing

6. In a shear wall, is the shear reinforcement horizontal or vertical?
   Horizontal

7. What is a lintel?
   Beam over an opening

8. What are the two primary reasons that expansion joints are put in brick veneer?
   Thermal expansion; irreversible moisture expansion

9. What are the axes of an interaction diagram?
   x-axis: moment
   y-axis: axial load

10. Draw an elevation view of stack bond masonry.
1. (4%) The structural notes for a building call for filling the cells of a concrete masonry wall with 3000 psi concrete. Is there anything wrong with this specification? If so, what?
Yes. Fill cells with grout, which has a higher slump and smaller aggregate size than typical 3000 psi concrete.

2. (4%) A. At what point in time is a clay brick the smallest it will ever be? Why? Ignore volume changes due to temperature.
B. At what point in time is a concrete block the smallest it will ever be? Why? Ignore volume changes due to temperature.
Brick will be smallest when it comes out of the kiln; grows due to moisture expansion.
Block will be smallest at end of life; shrinks even after curing

3. (4%) For a reinforced partially grouted masonry wall, is the position of the reinforcement along the length of the wall, or through the thickness of the wall, more important? Why?
Through the thickness of the wall; small changes in position will have a large effect on d. Along the wall, changes in position have less of an effect on d, since d is much larger.

4. (4%) Sketch the shear stress distribution in an unreinforced masonry shear wall. Show all critical values in terms of V/A.
Shear stress follows a parabolic distribution, with maximum stress being 1.5V/A
5. (6%) There are two primary failure modes of an unreinforced masonry shear wall. What are the failure modes, and which equation in Section 2.2.5.2 checks each failure mode?
   Diagonal tension: equation (a)
   Sliding: equation (c), (d), and (e)

6. (6%) The compressive strength of Type N mortar is 750 psi. However, the prism strength of a concrete masonry wall constructed using Type N mortar is 1350 psi. Explain how the prism can be stronger than the mortar.
   The mortar is confined by the units and in a biaxial state of stress in the wall. The mortar is tested as 2 inch cubes, and is in close to a uniaxial stress state during testing.

7. (6%) Explain how grout samples are to be made for compressive strength testing.
   A mold is formed with four concrete masonry units, and absorbent paper is put between units and grout. This simulates the actual field conditions.
8. (6%) A partially grouted wall is designed based on it being a non-bearing wall. Later on, in a modification to the building, the owner would like to use this as a bearing wall. You are asked if this is economically feasible. What would be your answer? Provide a short justification for your answer.
From the interaction diagram, axial loads will actually increase the flexural capacity of the wall up to a point. Unless the additional load is large, it will actually increase the capacity.

9. (6%) You have set up a spreadsheet to design solidly grouted masonry retaining walls based on the allowable stress design provisions. A person using the spreadsheet feels the program is in error since when they double the amount of reinforcing, the program shows only a slight increase in the capacity of the wall. What might be an explanation for this?
Allowable moment is being controlled by masonry; in this case the amount of steel only has a small effect on allowable moment.

10. (6%) When designing reinforced masonry for pure flexure using allowable stress design provisions, we can calculate a balanced reinforcing ratio. What is the significance of a balanced reinforcing ratio?
In allowable stress design, the balanced ratio has no physical meaning. It is simply the point where both the steel and the masonry are at their allowable stresses.
11. (6%) You need to construct an interaction diagram for a partially grouted reinforced masonry wall subjected to out-of-plane bending. Strength design is being used. The budget for this project only allows you to find four points on the interaction diagram. Which four points would you find? Describe each point in sufficient detail (e.g. a strain distribution, one strain and the location of the neutral axis, or a particular type of load) so that the point is uniquely defined.

- Zero moment, axial load
- Zero axial load, moment
- Balanced condition
- Any other reasonable point

12. (6%) Strength design of reinforced masonry uses a resistance factor of 0.9 for combinations of flexure and axial load. Why are we able to use this high of resistance factor, even under large axial loads, and never have to use a lower resistance as we do in reinforced concrete?

- The maximum reinforcing provisions limit the amount of steel. This forces a ductile failure, or the steel to yield before the masonry crushes. The sections are never compression controlled.

13. (6%) Strength design requires that the design shear strength of a shear wall exceed the shear corresponding to 1.25 times the nominal flexural strength. What is the purpose of this provision?

- The provision is for ductility. It forces a flexural failure, which is ductile, before a brittle shear failure.
(20%) An elevation view of a masonry wall is shown below. The opening is a large plate glass window. The wall will be reinforced and is simply supported at the ground and the roof. The wall is subjected to a concentric dead load of 1.3 kip/ft along the top of the wall. The wall is subjected to an out-of-plane wind load of 18 psf. Determine the critical load combinations that would be used to design the piers for out-of-plane loads. Express the critical case(s) as a combination of axial load and moment. Use allowable stress load combinations. Assume the wall weighs 46 psf.

Since load is concentric, maximum moment is at midheight. Tributary width is 6 ft.
Wind load moment is 6ft(18psf)(12ft)^2/8 = 1.944 kip-ft
Superimposed dead load: 1.3kip/ft(6ft) = 7.8 kips
Wall weight at midheight: 46psf(4ft)(6ft) = 1.104 kips
Tributary wall weight above opening: 46psf(4ft)(2ft) = 0.368 kips
Total dead load: 7.8+1.104+0.368 = 9.27 kips

D+W: P=9.27 kips, M=1.94 kip-ft
0.6D+W: P=5.56 kips, M=1.94 kip-ft (probably controls; axial load increases capacity)