

## 4.461 Building Technology I: Materials and Construction

### Quiz 2: Solution Set

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Quiz 1: Covers Chapters 1, 2 and first portion of Chapter 3 (to page 101)

Duration: 1.5 hours

Grading: 100 possible points

Quiz 1 + Quiz2 + Quiz3 + Quiz4 = 50% of total grade

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#### True or False: 10 questions (1 point each)

1. Balloon framing is inherently more fire resistant than platform framing.  
False
2. Timber framing uses metal strapping as the primary lateral resistance system.  
False
3. OSB should never be used as a structural material in engineered lumber.  
False
4. Roof trusses are used widely because of their speed of erection, moment joints and long spans.  
False: roof trusses do not have moment joints.
5. A pile is driven into the ground as opposed to drilled and poured.  
True
6. A noncurrent, noncoplanar force system is applied to a rigid body in three-dimensional space. Six equations of equilibrium are required to establish translational and rotational equilibrium.  
True
7. A downward vertical force,  $P$ , applied directly to a pin joint will result in an upward vertical reaction of  $P/2$ .  
False: result in a upward  $P$  force.
8. In timber construction, tie rods counter lateral thrusts from arches and other sloped members of a rigid frame.  
True
9. In light wood framing construction, a header is used to redirect the vertical forces from the structure above as they encounter an opening.  
True
10. Let-in diagonal bracing is used with nonstructural sheathing to provide lateral resistance to a light wood frame.  
True

#### Short Answers: 10 questions (2 points each)

11. What value does redundancy of structure provide in light wood framing construction?  
2/3: ease of making openings by removing studs and inserting headers, structural safety against collapse, ease of construction using smaller and lighter individual members (studs).
12. Why is timber framing generally costly in comparison to light wood framing?  
2/3: building necessitates custom structural engineering, wood members themselves are more costly because of their larger section sizes, construction requires heavy equipment, especially cranes.
13. Why is engineered lumber a cost effective alternative to lumber for structural members such as joists?

2/3: Eng. Lumber is composed of lesser grades and smaller pieces of wood, each member has a lower cost per unit of service (that is, stiffer and stronger with less material), and most sections are lighter for the same spans because more efficient sections can be built up.

14. In Europe, and increasingly in the US, why is siding applied to wood framing usually in the form of a rainscreen?  
2/3: creates a pressure buffer in the form of a pressure equalization chamber, provides a free drainage path for any leakage through the siding, and permits rapid drying of the siding if it should become soaked with water.
15. Why is homasote and regular gypsum board not used as an exterior sheathing material?  
1/1: neither material is sufficiently nonporous
16. What is a temperature gradient and how is it affected by the assembly materials of an exterior envelope?  
2/2: A temperature gradient is simply the presence of a temperature differential. It is always affected by the materials that are placed within it because every material poses a certain resistance to the flux of heat energy.
17. What are the two distinct ways for water vapor to be forced to condense?  
2/2: lower the temperature so that the relative humidity reaches 100% and add water vapor until, again, the R.H. reaches 100%.
18. What is the purpose of a radiant barrier and what materials behave most effectively in that role?  
2/2: a radiant barrier reduces the amount of radiant heat energy that is transferred between two surfaces. The most efficient materials are those whose surfaces are either metallic (shinier the better) and or light colored.
19. In light wood framing, a vapor barrier can be achieved using the typical interior materials of the construction. What materials are used and what is this vapor barrier approach called?  
2/2: materials used include the typical components of drywall construction with the inclusion of more effective (airtight) taping of the joints and sealants at the ceiling and floor. This approach called the Airtight Drywall Approach.
20. Historically, three types of walls have been used to produce a viable barrier to the elements. What are they, and how does each type satisfy the requirements of a working exterior envelope?  
3/3: The three types are: (1) mass wall; through substantial mass, stone, log, earth etc. this system absorbs water and thermal flux through the presence of a great deal of the material itself (2) sealed wall; through a perfectly continuous surface, this type resisted any penetration of water or air (3) rainscreen (or simply screen): through the redundancy of a non-sealed layer as the outer most layer this system tempers the mechanical action on the barrier layers by providing a thin volume of air just inside the cladding.

### Long Answers: 3 questions (10 points each)

21. In the construction of contemporary buildings, what are the primary issues that form the discourse regarding sustainable wood structures?  
3/5 with substantial discussion of why each is a primary issue.
- Forest coverage and or protection of 'frontier' forests
  - Biodiversity
  - CO<sub>2</sub> (and other greenhouse gas) emissions
  - Construction and Demolition Waste reduction
  - Low energy wood assemblies, such as 2x6 stud walls allowing for more insulation than typical.
22. What are the primary sources of wood? (from: *Wood Fiber Consumption and the World's Forests*). What are the trends in the global consumption of wood?  
First Part. 3/3: Large tracts of old-growth forest, secondary-growth forests, plantations  
Second Part. 2/4 – there may be other valid trends that are not mentioned below (see *Forest Loss*).
- Continuing forest loss globally
  - Half of the world's natural forest has been destroyed, with much of this occurring in the last 3 decades.

- Globally, natural forests continue to be lost, while the rate of reforestation, the growth of plantations, afforestation, and the natural expansion of forests is increasing.
- Half of the world's consumption of wood is still used for fuel. The vast majority of this fuel wood is harvested in the developing regions of the world.

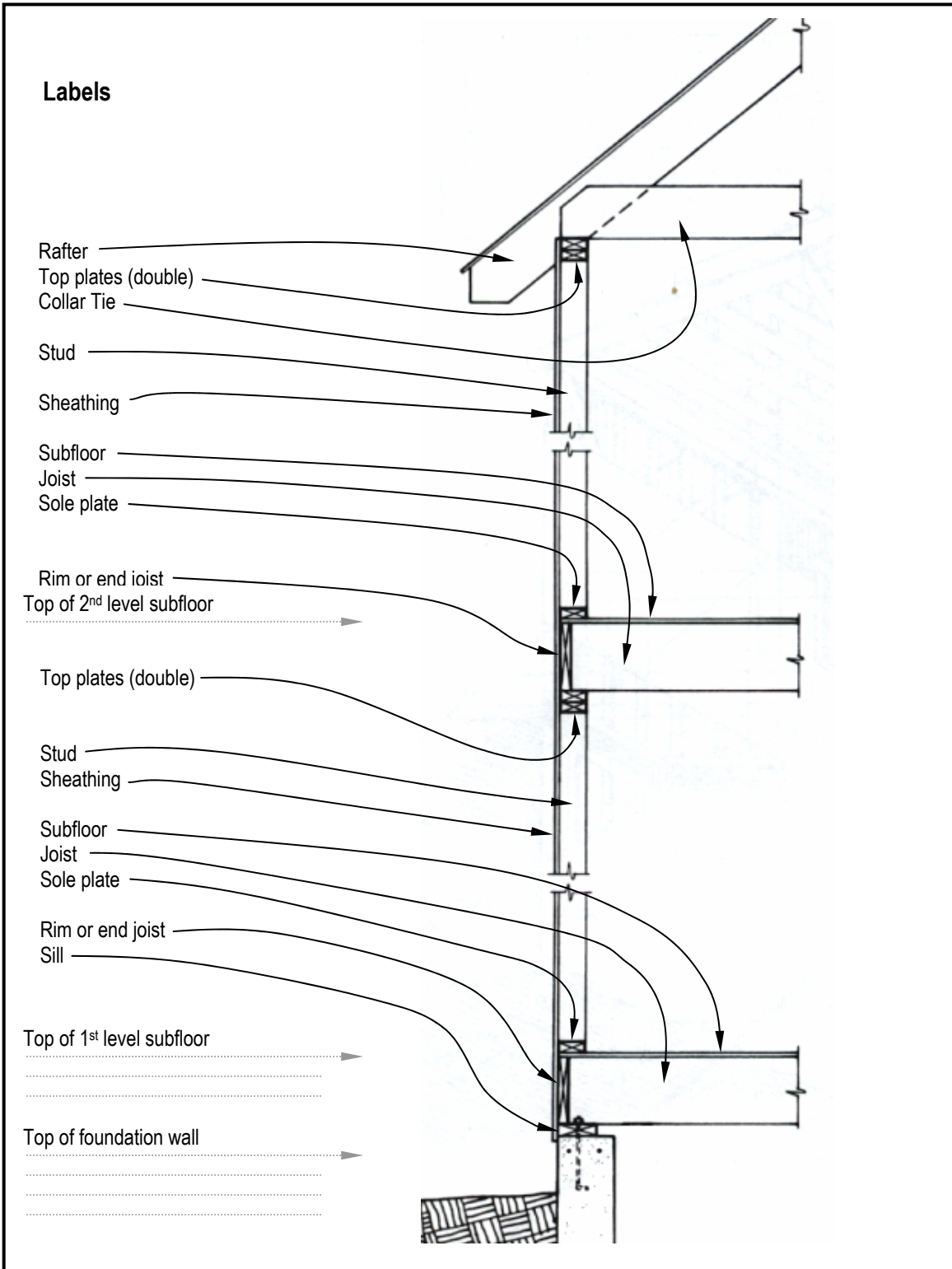
23. What are the future trends in the development of wood-based products for construction?

2/5:

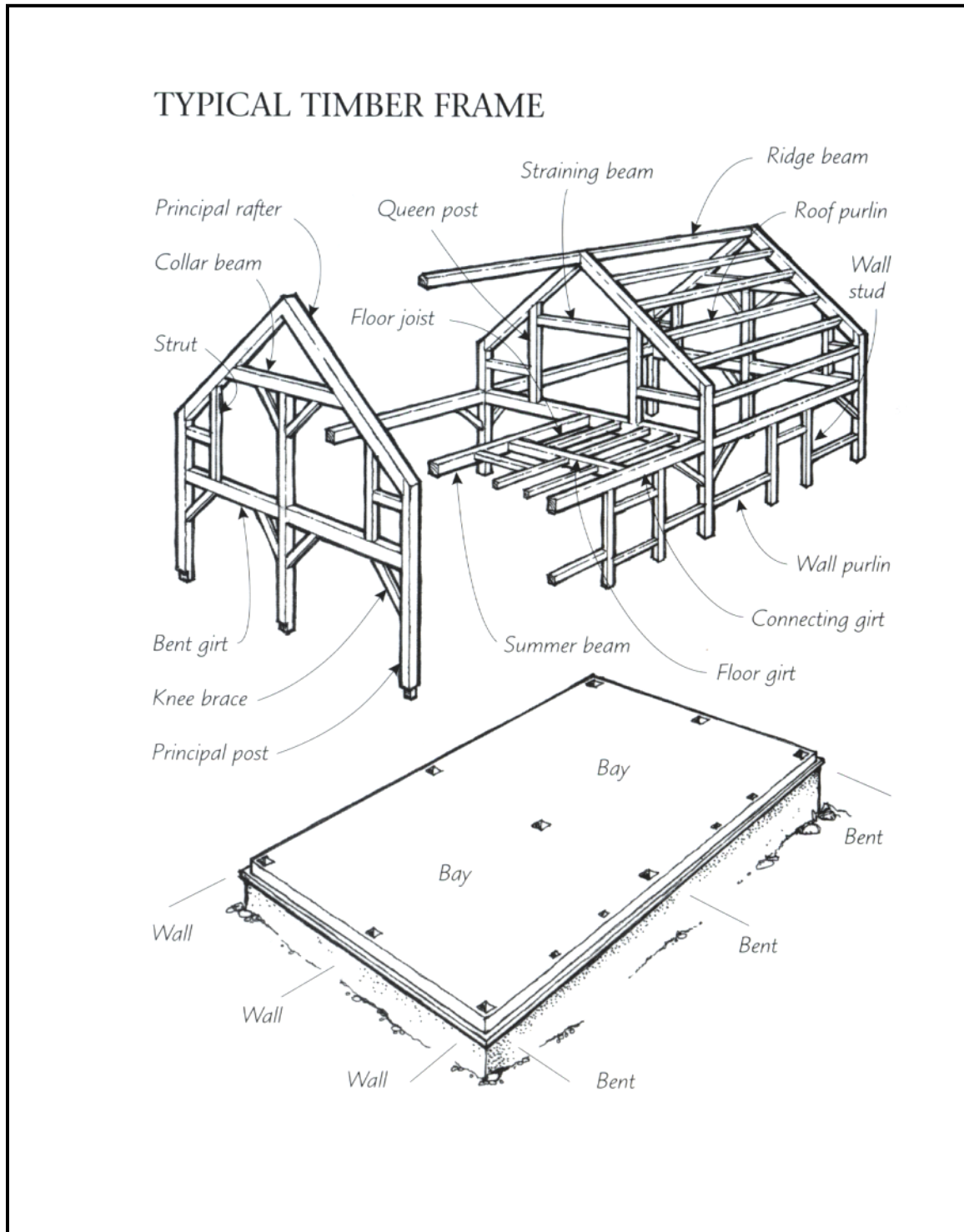
- Better preservatives
- Additions to the variety of wood composite materials
- Hybrid wood composites
- Textile reinforced structural wood products
- Development of environmentally responsible products and processes for wood in construction

**Visual inspection and Drawing: 3 questions (40 points total)**

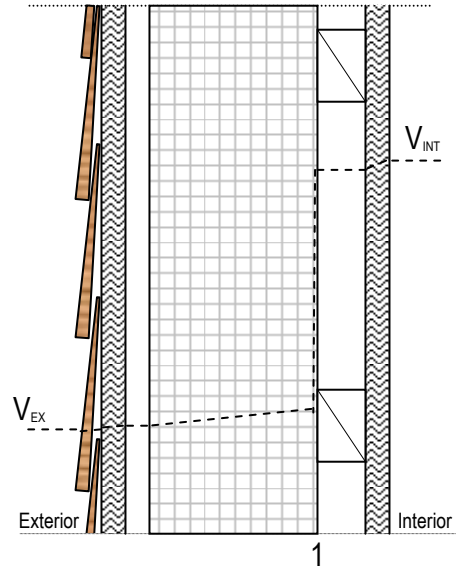
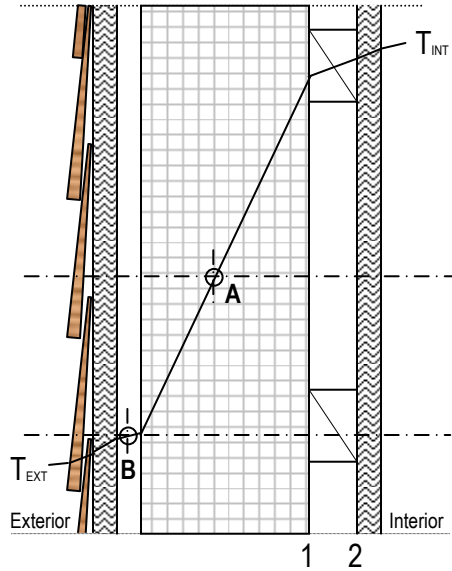
24. Draw a typical section of a contemporary light wood platform frame showing, and labeling, all of the major wood components. (12 points)



25. Label the components of the timber frame (10 points)  
5/8:



26. Consider each scenario. (18 points)



A. Describe two distinct ways in which the condensation point can be moved from Point A to Point B.

Solution: 2/2  
 1. Air drywall approach  
 2. Add vapor barrier at 1 or 2.

B. Explain the vapor pressure gradient shown above.

Solution: 1/1  
 Vapor barrier exists at 1.

C. Improve the following section.

Vapor barrier    ···········

Air barrier      - - - - -

Radiant barrier    — · · — · · —

$T_{EXT} > T_{INT}$

Solution: 3/3  
 1. Eliminate one of the air barrier layers.  
 2. Move the radiant barrier to position 1.  
 3. Move vapor barrier to position 1.

