ARCH 631. Study Guide for Final Examination

This guide is not providing "answers" for the conceptual questions. It is a list of topical concepts and their application you should be familiar with. It is an *aid* to help prepare for the final exam.

Material not previously covered by mid-term exam study has bold section headers.

Steel Design

- ☐ Design methodologies
- ☐ Steel grades (standard properties)
- ☐ Yield strength vs. ultimate strength
- ☐ Local buckling in web & flange
- ☐ Bearing on flange
- ☐ Plastic section modulus
- ☐ Plastic moment & plastic hinges
- ☐ Braced vs. unbraced length
- ☐ Use of beam moment capacity charts
- ☐ Equivalent uniform load based on maximum moment
- ☐ Slenderness criteria & l/r
- ☐ *with respect to least radius of gyration*
- ☐ Compact section criteria
- ☐ Use of column load capacity charts
- ☐ Beam-columns
- ☐ Interaction equations (P-Δ)
- ☐ W (first number meaning) x (second number meaning)
- ☐ Bolt designations
- ☐ Gross area
- ☐ Effective net area
- ☐ Area of web
- ☐ Connection types
- ☐ Weld strengths
- ☐ Throat thickness
- ☐ Fillet, butt, plug, slot
- ☐ Coping
- ☐ Tension member
- ☐ Simple shear connector
- ☐ Single vs. double shear
- ☐ Capacity of a connection
- ☐ Block Shear Rupture
- ☐ Design vs. analysis
- ☐ Decking
- ☐ Gusset plates
- ☐ Web stiffener plates
- ☐ Open web joists and use of design charts
- ☐ Equivalent uniform load from maximum moment
- ☐ Column base plate dimensioning
- ☐ Beam shear splice
- ☐ Eccentrically loaded bolt group

Masonry Design

- ☐ Design methodology
- ☐ The fact that masonry can resist tension without steel!
- ☐ Brick, block, CMU, etc.
- ☐ Grout vs. mortar
- ☐ MASONWORK
- ☐ Masonry strength (prisms)
- ☐ Grouting cover and purpose
- ☐ Moisture and clay unit durability
- ☐ Combined stresses for walls
- ☐ Virtual eccentricity
- ☐ Lintels and arching action + load distribution
- ☐ Interaction equations (P-Δ)
- ☐ Pilasters
- ☐ Design vs. analysis

Foundation Design

- ☐ Design methodology (separate from reinforced concrete design)
- ☐ Net soil pressure vs. allowable soil pressure
- ☐ Overburden
- ☐ Sliding and overturning (stability)
- ☐ Settlement
- ☐ Active vs. passive pressure
- ☐ Foundation types
- ☐ Foundation parts (key, counterfort, etc...)
- ☐ Shallow foundations vs. deep foundations
- ☐ Kern and pressure distribution
- ☐ Shear resistance and bearing resistance of piles
- ☐ Design vs. analysis
- ☐ Reinforced concrete design for shear and bending
- ☐ One-way vs. two-way shear (load & strength)
- ☐ Location of maximum shear in beams & footings
- ☐ Location of maximum moment in footings
- ☐ Embedment length
- ☐ Bearing and dowels

Structural Supervision

- ☐ Steel grade
- ☐ Concrete mix design & slump
- ☐ Concrete cylinders
- ☐ Masonry prisms
- ☐ Clear (of grout) cavities for moisture
- ☐ Protection of timber from weather
- ☐ Bracing during construction
- ☐ Tolerances for assembly

General: Systems

- ☐ One-way vs. two-way systems
- ☐ Truss configurations and assumptions for analysis
- ☐ Zero-force member
- ☐ Special truss member configurations at joints and conditions
- ☐ Basis of graphical truss analysis (aka Maxwell's diagram)
- ☐ Compound truss
- ☐ "Cable" truss members
- ☐ "Shear & Moments" in parallel chord trusses
- ☐ Lenticular truss
- ☐ Vierendeel "truss"
- ☐ Catenary shape, sag
- ☐ Cable-stayed
- ☐ Pinned arches (2 vs. 3) & rigid arches
- ☐ "Thrust"
- ☐ Rigid vs. non-rigid pinned frames
- ☐ Rigid frame behavior
- ☐ Connection types and load/moment transfer
- ☐ Moment "redistribution"
- ☐ Methods for analysis of statically indeterminate frames
- ☐ Effect of relative frame member stiffnesses
- ☐ Types and purpose of bracing
- ☐ Sidesway
- ☐ Bearing, shear, curtain walls ...
- ☐ Cantilever method with lateral forces

General: Columns

- ☐ Stability
- ☐ Buckling vs. crushing
- ☐ Slenderness
- ☐ Critical Buckling and Euler's Formula
- ☐ Effective length, K & bracing (end conditions)
- ☐ Beam-Columns (eccentric loading)
- ☐ Combined bending and compression – *interaction equations or diagrams*
- ☐ P-Δ effect
- ☐ Eccentricity
- ☐ Kern

Statics & Mechanics

- ☐ Vectors and scalars
- ☐ Parallelogram law
- ☐ Tip-to-tail method
- ☐ Internal vs. external forces
- ☐ Tension and compression
- ☐ Resultant of a force
- ☐ Component of a force
- ☐ Moment of a force
- ☐ Moment of a distributed load
- ☐ Moment Couple
- ☐ Equivalent Force Systems
- ☐ Concurrent vs non-concurrent force systems
- ☐ Equilibrium
- ☐ Newton's First Law
- ☐ Direction and type of force in a cable with relation to geometry
- ☐ Free Body Diagram
- ☐ Reactions at a support and relationship to motion prevented
- ☐ Statically Determinate vs. Indeterminate
- ☐ Two-force bodies and relationship to loads
- ☐ Three-force bodies
- ☐ Fixed-end moment reactions
- ☐ Pin connections
- ☐ Method of Joints
- ☐ Method of Sections
- ☐ Actions vs. reactions
- ☐ Internal shear, axial force & bending moment
- ☐ Inflection point on moment diagram
- ☐ Effect of forces on shear diagram
- ☐ Effect of moments on moment diagram
- ☐ Location of zero shear (x) and relation to maximum moment
- ☐ Slope relationships with integration
- ☐ Normal stress (compression & tension)
- ☐ Shear stress (non beams)
- ☐ Bearing stress
- ☐ Bending & shear stress (beams)
- ☐ Torsional (shear) stress (with respect to shape and where maximum occurs)
- ☐ Relation of strain to stress & Modulus of Elasticity
- ☐ Brittle, Ductile & Semi-brittle material behavior
- ☐ Yield strength (or point & proportional limit)
- ☐ Elastic vs. plastic range
- ☐ Ultimate strength
- ☐ Strength vs. stress
- ☐ Rupture / Fatigue behavior
- ☐ Creep
- ☐ Orthotropic vs. Isotropic vs. Anisotropic materials
- ☐ Stress concentration
- ☐ Thermal vs. elastic strains
- ☐ Geometric constraints
- ☐ Serviceability
- ☐ Buckling
- ☐ Deflections & elongation
- ☐ Stiffness (relative to EI/L through Δ, or AE/L through δ)
- ☐ *Superpositioning*
- ☐ Single vs. double shear

General: Planning

- ☐ One-way vs. two-way systems
- ☐ "Collectors"
- ☐ Vertical & horizontal grid considerations
- ☐ Long span considerations
- ☐ Effect of loading types on system efficiency
- ☐ Options for corners, large spaces, etc.
- ☐ Integration with building services
- ☐ Fire safety and planning
- ☐ "Weakness" Areas (Tolerances, Lateral bracing, etc.)

General: Design

- ☐ Allowable Stress Design
- ☐ Load and Resistance Factor Design
- ☐ Factored loads
- ☐ Resistance Factors
- ☐ "Design" values vs. "Capacity"
- ☐ Factor of Safety
- ☐ Density of materials and relation to weight
- ☐ Load types (and directions) (*like D, L, S ...)*
- ☐ Minimum loads (building codes)
- ☐ Load combinations
- ☐ Serviceability and limits (ex. ponding)
- ☐ Live load reduction
- ☐ Building codes vs. standards vs. structural codes
- ☐ Stability of systems & members
- ☐ Design vs. analysis
- ☐ Efficiency
- ☐ Load tracing & (con)tributary width (vs. area)
- ☐ Static vs. dynamic loads
- ☐ Equivalent static wind load & pressure
- ☐ Concentrated loads
- ☐ Distributed loads – uniform / non-uniform
- ☐ Result of acceleration on a mass and Weight
- ☐ Period of vibration, frequency, damping & resonance

General: Beams

- ☐ Simply supported
- ☐ Overhang
- ☐ Cantilever
- ☐ Continuous
- ☐ w vs. W
- ☐ Equivalent center of load area
- ☐ Built-up shape
- ☐ Centroid, moment of inertia, *Q*, radius of gyration
- ☐ Neutral axis, section modulus, extreme fiber
- ☐ Negative area method
- ☐ Parallel axis theorem
- ☐ Maximum bending stress (& location along length and in cross section)
- ☐ Maximum shear stress (& location along length and in cross section)
- ☐ Maximum shear stress by beam shape (proper equations)
- ☐ Shear flow and shear center
- ☐ Lateral buckling (and bracing)
- ☐ Torsion stresses and cross section shape
- ☐ Stress types in beams
- ☐ Self-weight
- ☐ Deflections & superpositioning (+ *units)*
- ☐ Use of Beam Diagrams and Formulas
- ☐ Principal stresses
- ☐ Efficient cross-section shapes
- ☐ Shaping a beam along the length for efficiency.
- ☐ Location of supports and efficiency.
- ☐ "Effective length" and points of inflection
- ☐ Methods for analysis of statically indeterminate beams
- ☐ Support settlements and stress redistribution
- ☐ Loading patterns for spans

General: Membranes & Shells

- ☐ Appropriate loads & primary stresses
- ☐ Air-supported vs. air-inflated
- ☐ Materials, durability, and punctures
- ☐ Profiles and wind effects
- ☐ Shell vs. not shell (stresses are key)
- ☐ Meridional vs. Hoop
- ☐ Shell forces vs stresses (with respect to thickness and strips)
- ☐ Tension vs. compression rings
- ☐ "Thrust"
- ☐ Buckling and "snap-through"
- ☐ Anticlastic shell properties
- ☐ Pressure vs. membrane stress
- ☐ Curvature and membrane stress
- ☐ Hyperbolic paraboloid

General: Plates & Grids

- ☐ Plate vs. slab
- ☐ One-way vs. two-way behavior
- ☐ Aspect ratio (with respect to bay dimensions)
- ☐ Space frame vs. grid
- ☐ Unit width for design
- ☐ Moment redistribution
- ☐ Pan joists, T sections & effective width of flange
- ☐ Drop panels
- ☐ Boundary conditions & effect on deflections / moments
- ☐ Point loads and effect on deflections / moments
- ☐ Simplified Frame Analysis & "Strip" method
- ☐ Design shear & moments (spans "integral with support", first interior support, etc.)
- ☐ Direct design method for two-way slabs & M_o
- ☐ Solutions for large shear at space frame supports
- ☐ Moment of inertia with respect to folded plates
- ☐ Reason for stiffening of folded plates
- ☐ Live load reduction
- ☐ Thickness as a fraction of bay span (L)
- ☐ "Punching" shear at columns

Reinforced Concrete

- ☐ Cast-in place, precast, prestressed (pretensioned), post-tensioned
- ☐ Constituents to make concrete
- ☐ Slump
- ☐ Behavior in compression vs. tension of concrete
- ☐ Design methodology
- ☐ 28-day compressive strength
- ☐ Term "working stress design"
- ☐ Creep
- ☐ Camber (hogging & sagging)
- ☐ "composite"
- ☐ Transformed section
- ☐ Depth of the Whitney stress
- ☐ Moment capacity (or ultimate strength) vs. nominal moment (or strength)
- ☐ Factored design moment (or shear or ....)
- ☐ Design stress in reinforcement
- ☐ Design stress in concrete
- ☐ Reinforcement grades
- ☐ Reinforcement ratio
- ☐ Effective depth vs. depth of a beam
- ☐ Under-reinforced vs. over-reinforced
- ☐ Balanced-steel condition
- ☐ Purpose of minimum reinforcement area requirement
- ☐ Why development length is necessary
- ☐ Use of Strength Design Curves (R_n)
- ☐ Purpose of stirrup requirement when concrete capacity is available
- ☐ Diagonal tension cracks
- ☐ Stirrup strength
- ☐ Shrinkage
- ☐ Concrete cover and purpose
- ☐ #3 bar (meaning of the numeral)
- ☐ Purpose of compression reinforcement
- ☐ T-section behavior and stresses in flange
- ☐ One-way joists, vs. beams, vs. girders
- ☐ "Spandrel"
- ☐ One-way slab design and "unit" strip
- ☐ One-way vs. two-way slabs
- ☐ One-way vs. two-way shear (load & strength)
- ☐ Plate vs. Flat Slab
- ☐ Continuous beam analysis with coefficients
- ☐ Clear span / span length
- ☐ Columns with ties vs. spirals (stresses, factors, etc.)
- ☐ Interaction diagrams (P-Δ)
- ☐ Location of maximum shear in beams
- ☐ Live load reduction
- ☐ Beam self weight relationship to material density (150 lb/ft^3)
- ☐ Design vs. analysis

General: Lateral Loads

- ☐ Lateral stability vs. gravity loading
- ☐ Resisting mechanisms
- ☐ "In-plane" forces
- ☐ Load transfer and shear planes
- ☐ Torsional deformations
- ☐ Horizontal vs. vertical shear planes
- ☐ Diaphragm action
- ☐ Diaphragms, shear walls, bracing, frame action, drag struts, chevron, knee, etc.
- ☐ Selective placement of horizontal and vertical rigid planes
- ☐ Member orientation for frame action
- ☐ Mechanism choices with building height
- ☐ Behavior of multistory frames under lateral load.
- ☐ Behavior of "tubes"
- ☐ Serviceability issues, dampers

Hazards Design

- ☐ Equivalent static wind pressure, direction, size with respect to building height, formula
- ☐ Wind speed & 50 year return period
- ☐ Vortex shedding
- ☐ Flutter
- ☐ Windward, leeward
- ☐ Flood zones & "100 year flood"
- ☐ Hydrostatic pressure calculation (linear with depth of water by density = γh)
- ☐ Dynamic loads
- ☐ Fault zones, focus (hypocenter), epicenter
- ☐ Magnitude, duration, intensity of ground motion
- ☐ Liquefaction, landslides, subsidence, tsunami
- ☐ Inertial forces (mass, acceleration)
- ☐ Base shear and code formulas
- ☐ Overturning
- ☐ Resonance, frequency, period of vibration, damping
- ☐ Stiffness - lateral and torsional
- ☐ Center of mass, center of rigidity
- ☐ Drift and shear distribution by floor mass
- ☐ Pounding, re-entrant corners, soft stories
- ☐ Seismic joints, base isolation, tuned mass dampers
- ☐ Period length relationship to stiffness
- ☐ "Spring-mass" assembly model
- ☐ Redundancy and continuity
- ☐ Non-structural elements contribution to stiffness
- ☐ Spectrum or spectral response
- ☐ NEHRP (actual name and function)

General: Connections and Tension Members

- ☐ Normal stress (compression & tension)
- ☐ Shear stress (non beams)
- ☐ Bearing stress
- ☐ Pinned joint vs. rigid joint
- ☐ Single shear vs. double shear
- ☐ Simple shear connector
- ☐ Connected area for longitudinal shear stress calculation
- ☐ Nail capacity and pitch for resisting longitudinal shear
- ☐ Effective area vs. net area vs. gross area of tension member
- ☐ Forces and stresses resisted by nails, adhesives, split ring connectors, bolts, etc.
- ☐ Rupture vs. yielding in steel
- ☐ Bolt designations
- ☐ Weld strengths
- ☐ Throat thickness
- ☐ Fillet, butt, plug, slot
- ☐ Coping
- ☐ Block shear rupture
- ☐ Web "crippling"

Timber Design

- ☐ Lumber vs. engineered timber characteristics (ex: glulam)
- ☐ Light-frame vs. heavy timber construction
- ☐ Lumber grading
- ☐ Various strengths (directionality, wood type, etc.)
- ☐ Built-up member types
- ☐ Design methodologies and obtaining allowed stresses (adjustment factors - duration, multiple member use....)
- ☐ Creep
- ☐ Nominal dimensions
- ☐ Beam self weight with respect to material density (variable for wood types)
- ☐ Column stability factor, F_{CE} & l/d
- ☐ Interaction equations (P-Δ)
- ☐ Connection stresses
- ☐ Design vs. analysis
- ☐ Bolt designations
- ☐ Effective net area
- ☐ Connection types
- ☐ Single vs. double shear
- ☐ Bolt capacity charts and relation to wood strengths
- ☐ Allowable shear capacity charts for diaphragms
- ☐ Chord forces in diaphragms