ARCH 331. 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.

General Structures

- ☐ Dead, live, wind, snow, seismic, impact load types
- ☐ Structural system organization schemes and materials
- ☐ Structural component names
- ☐ Number of levels in horizontal systems
- ☐ Structural system performance requirements (design criteria)
- ☐ Analysis vs. evaluation
- ☐ Grids and patterns
- ☐ Lateral resistance options
- ☐ Horizontal span to depth relationship
- ☐ One-way vs. Two-way systems
- ☐ Load type with respect to structure type

Statics

- ☐ Sin, Cos, Tan, opposite, adjacent & hypotenuse
- ☐ Perpendicular
- ☐ Result of acceleration on a mass and Weight
- ☐ Law of transmissibility
- ☐ Internal vs. external forces
- ☐ Tension and compression
- ☐ Collinear, Coplanar, Space, Concurrent & Parallel force systems
- ☐ Vectors and scalars
- ☐ Scale
- ☐ Force Polygon
- ☐ Parallelogram law
- ☐ Tip-to-tail method
- ☐ Resultant of a force
- ☐ Component of a force
- ☐ Direction and type of force in a cable with relation to geometry
- ☐ Static friction vs. kinetic friction
- ☐ Equilibrium
- ☐ Newton's First Law
- ☐ Newton's Third Law
- ☐ Free Body Diagram
- ☐ Reactions at a support and relationship to motion prevented
- ☐ Short link or cable, roller, rocker, pin or hinge, smooth surface, rough surface, fixed
- ☐ Two-force bodies and relationship to loads
- ☐ Three-force bodies
- ☐ Pinned connections
- ☐ Method of Joints
- ☐ Method of Sections
- ☐ Negative result for a variable from equilibrium equations from free body diagram
- ☐ Moment of a force
- ☐ Varignon's Theorem
- ☐ Moment Couple
- ☐ Equivalent Force Systems
- ☐ "Best" location for summation of moment
- ☐ Statically Determinate vs. Indeterminate
- ☐ Actions vs. reactions

Mechanics of Materials

- ☐ Scale (square-cube) effect
- ☐ Normal stress (compression & tension)
- ☐ Shear stress (non beams)
- ☐ Bearing stress
- ☐ Bending & shear stress (beams)
- ☐ Torsional (shear) stress (and where maximum occurs)
- ☐ Shear stress in round, rectangular, open and closed thin-walled sections
- ☐ Relation of strain to stress & Modulus of Elasticity

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Mechanics of Materials (continued)

- ☐ Brittle, Ductile & Semi-brittle material behavior
- ☐ Yield strength (or point & proportional limit)
- ☐ Ultimate strength
- ☐ Strength vs. stress
- ☐ Rupture / Fatigue behavior
- ☐ Orthotropic vs. Isotropic vs. Anisotropic materials
- ☐ Creep
- ☐ Stress concentration
- ☐ Thermal vs. elastic strains
- ☐ Geometric constraints
- ☐ Dynamics vs. Statics
- ☐ Serviceability
- ☐ Deformation with stress (deflection & elongation)
- ☐ *Superposition method*
- ☐ Stiffness (relative to EI/L through Δ, or AE/L through δ)
- ☐ Single vs. double shear

General: Beams

- ☐ Concentrated loads
- ☐ Distributed loads – uniform / non-uniform & hydrostatic
- ☐ Beam support configurations
- ☐ Simply supported
- ☐ Overhang
- ☐ Cantilever
- ☐ Restrained
- ☐ Continuous
- ☐ Compound beams with pins
- ☐ w vs. W
- ☐ Equivalent center of load area
- ☐ Load tracing & tributary width (vs. area)
- ☐ Types of beam stresses
- ☐ Prestressing or post tensioning
- ☐ Influence of moment, material, and cross section on deflected shape
- ☐ Internal shear, axial force & bending moment
- ☐ Inflection point
- ☐ The Equilibrium Method
- ☐ The Semigraphical Method
- ☐ Areas under a curve and *change*
- ☐ Effect of forces on shear diagram
- ☐ Effect of moments on moment diagram
- ☐ Location of zero shear (x) and relation to maximum moment
- ☐ How to find location of zero shear
- ☐ Slope relationships with integration
- ☐ Positive vs. negative bending moment "shape"
- ☐ How to use Beam Diagrams and Formulas for shear and bending moment
- ☐ Composite shape
- ☐ Centroid, moment of inertia, Q, radius of gyration
- ☐ Neutral axis, section modulus, Q, 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)
- ☐ Economical selection by A or S charts
- ☐ Shear flow and shear center
- ☐ Connected area
- ☐ Nail capacity and pitch for resisting longitudinal shear
- ☐ Moment *redistribution* for statically indeterminate beams
- ☐ Lateral buckling (and bracing)
- ☐ Stress types in beams
- ☐ Self-weight
- ☐ Relation of strain to stress & modulus of elasticity
- ☐ Stiffness (relative to EI/L through Δ)
- ☐ Deflections & superpositioning (+ *units)*
- ☐ Rafter, joist, girder, decking
- ☐ Equivalent distributed load based on a maximum moment

General: Columns

- ☐ Stability
- ☐ Buckling
- ☐ Slenderness
- ☐ Critical Buckling and Euler's Formula
- ☐ Effective length, K & bracing
- ☐ Beam-Columns
- ☐ Combined bending and compression – *interaction*
- ☐ P-Δ effect
- ☐ Eccentricity
- ☐ Relative joint stiffness for determining effective length (ψ)

General: Systems

- ☐ Cable vs. cable-stay
- ☐ Truss configurations and assumptions for analysis
- ☐ Zero-force member
- ☐ Special truss member configurations at joints and conditions
- ☐ Basis of graphical truss analysis
- ☐ Compound truss, space truss, tensegrity
- ☐ Diagonal tension counters and solution method
- ☐ Lateral bracing and trusses
- ☐ Compression and trusses
- ☐ Indeterminate trusses
- ☐ Pinned arches and frames
- ☐ Rigid vs. non-rigid pinned frames
- ☐ Rigid frame behavior
- ☐ Internal pin connections
- ☐ Free Body Diagram rule for force at a pin of a frame
- ☐ Connection types and load/moment transfer
- ☐ Types and purpose of bracing
- ☐ One-way and two-way slab behavior and support types
- ☐ Load distribution for slab supports
- ☐ Rafter, joist, girder, decking, pilasters, bearing walls, shear walls
- ☐ Shallow vs. deep foundations
- ☐ Horizontal spanning levels and collectors
- ☐ Wind load tracing, and bracing configurations
- ☐ Space frame behavior
- ☐ Space frame supports and loads
- ☐ Folded plate behavior
- ☐ Folded plate buckling and stiffness requirements

General: Design

- ☐ Allowable Stress Design
- ☐ Load and Resistance Factor Design
- ☐ Working loads
- ☐ Factored loads
- ☐ Resistance Factors
- ☐ "Design" values vs. "Capacity"
- ☐ Factor of Safety
- ☐ Density of materials and relation to weight
- ☐ Static vs. dynamic loads
- ☐ Wind and dynamic response terms & behavior
- ☐ Load types (and directions) *(like D, L, S …)*
- ☐ Load combinations for ASD, LRFD
- ☐ Load patterns
- ☐ Building codes vs. structural design codes vs. material standards
- ☐ Minimum Design Loads & Requirements
- ☐ Serviceability and limits
- ☐ Design vs. analysis
- ☐ Equivalent distributed load based on a maximum moment
- ☐ Use of Load Tables

Timber Design

- ☐ Lumber vs. engineered timber characteristics
- ☐ Various strengths (directionality, wood type, etc.)
- ☐ Design methodologies and obtaining allowed stresses (duration, multiple member use....)
- ☐ Creep
- ☐ Nominal dimensions of timber
- ☐ Beam stresses specific to timber cross sections
- ☐ Decking, joist types, laminated arches, stressed-skin panels, box sections, trusses, lamellas
- ☐ Depth with respect to span length and shape
- ☐ Timber construction types
- ☐ Column stability factor, F_{CE} & l/d
- ☐ l/d limit for timber
- ☐ Effective length, K & bracing
- ☐ Beam-columns & interaction equations
- ☐ Connection stresses
- ☐ Design vs. analysis
- ☐ Bolt designations
- ☐ Effective net area
- ☐ Connection types
- ☐ Nail load capacity charts
- ☐ Bolt capacity charts and relation to wood strengths
- ☐ Single vs. double shear
- ☐ Stresses in built-up beam sections and the connectors

Steel Design

- ☐ Steel materials, hot-rolled, cold-formed, corrosion, fatigue, strength loss with heat
- ☐ Steel grades (standard properties)
- ☐ Yield strength vs. ultimate strength
- ☐ Local buckling in web & flange
- ☐ Lateral torsional buckling
- ☐ Bearing on flange
- ☐ Plastic section modulus
- ☐ Plastic moment & plastic hinges
- ☐ Braced vs. unbraced length
- ☐ W (first number meaning) x (second number meaning)
- ☐ Depth with respect to span length and shape
- ☐ Design methodologies – ASD & LRFD (Unified)
- ☐ Use of beam moment capacity charts
- ☐ Use of Load Tables
- ☐ Equivalent uniform load based on maximum moment
- ☐ Elastic deflection (serviceability)
- ☐ Economical selection by Z charts
- ☐ Horizontal distribution of sloped dead load
- ☐ Joist vs. beam vs. girder
- ☐ Plate girder
- ☐ Web stiffener plates
- ☐ Decking (composite vs. non)
- ☐ Open web joist
- ☐ Slenderness criteria & l/r
- ☐ *with respect to least radius of gyration*
- ☐ kl/r limit for steel
- ☐ Effective length, K & bracing
- ☐ Compact section criteria
- ☐ Use of column load capacity charts
- ☐ Check for column design efficiency
- ☐ Beam-columns and interaction equations
- ☐ Bolt designations
- ☐ Gross area
- ☐ Effective net area
- ☐ Area of web
- ☐ Connection types
- ☐ Weld strengths
- ☐ Throat thickness
- ☐ Fillet, butt, plug, slot
- ☐ Coping
- ☐ Tension member
- ☐ Shear lag
- ☐ Simple shear connector
- ☐ Single vs. double shear
- ☐ Capacity of a connection
- ☐ Block Shear Rupture
- ☐ Design vs. analysis
- ☐ Gusset plates

Reinforced Concrete Design

- ☐ Constituents to make concrete
- ☐ Construction: cast-in-place, prestress, post-tension, ... & finishing/casting terms
- ☐ Behavior in compression vs. tension of concrete
- ☐ Design methodology
- ☐ Load and Resistance Factor Design
- ☐ Working loads
- ☐ Factored loads
- ☐ Resistance Factors
- ☐ "Design" values vs. "Capacity"
- ☐ Density of materials and relation to weight
- ☐ Creep
- ☐ "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 (28-day)
- ☐ Effective depth vs. depth of a beam
- ☐ Reinforcement grades
- ☐ Reinforcement ratio
- ☐ Under-reinforced vs. over-reinforced
- ☐ Purpose of minimum reinforcement area requirement
- ☐ Why development length is necessary
- ☐ Use of Strength Design Curves (R_n)
- ☐ Depth with respect to span length and shape
- ☐ Purpose of stirrup requirement when concrete capacity is available
- ☐ Shrinkage
- ☐ Cracks
- ☐ Concrete cover and purpose
- ☐ Clear span / span length
- ☐ #3 bar (meaning of the numeral)
- ☐ Why bars need space between/around them
- ☐ Purpose of compression reinforcement
- ☐ T-section behavior and stresses in flange
- ☐ Precast load tables
- ☐ One-way slabs design and "unit" strip
- ☐ One-way shear vs. two-way shear (load & strength)
- ☐ Stirrup strength
- ☐ Location of maximum shear in beams
- ☐ Why torsional shear stirrups are "closed"
- ☐ Development/embedment length
- ☐ I transformed, I-cracked, E as a function of weight and cracking
- ☐ Minimum thicknesses for deflection control
- ☐ Plate vs. Flat Slab
- ☐ Openings redistribute stress (or cause concentrations) and increase deflections
- ☐ Openings should be reinforced for stresses and deflection control
- ☐ Continuous beam or slab analysis with coefficients
- ☐ Composite construction
- ☐ kl/r limit for concrete
- ☐ Effective column length for sway or non-sway frames
- ☐ Columns with ties vs. spirals (stresses, factors, etc.)
- ☐ Beam-columns and interaction diagrams
- ☐ Location and size of maximum one-way shear and two-way shear in spread footings
- ☐ Location of size maximum moment in spread footings
- ☐ Cover requirement in contact with soil
- ☐ Design pressure
- ☐ Bearing of column on spread footing
- ☐ Function of dowels
- ☐ Design vs. analysis

Foundation Design

- ☐ Shallow foundations: spread, wall, mat
- ☐ Deep foundations: piles, pile caps, grade beams
- ☐ Parts of retaining walls & types
- ☐ Loads on retaining walls (gravity, friction, equivalent fluid pressure, bearing pressure.
- ☐ Factor of safety of sliding and overturning
- ☐ Triangular or trapezoid shape of bearing pressure & relation to location of centroid of load
- ☐ Design methodology (separate from reinforced concrete)
- ☐ Net soil pressure vs. allowable soil pressure
- ☐ Overburden
- ☐ Sliding and overturning (stability)
- ☐ Settlement
- ☐ Active vs. passive pressure
- ☐ Foundation types
- ☐ Shallow foundations vs. deep foundations
- ☐ Kern and pressure distribution
- ☐ Design vs. analysis
- ☐ Shear resistance and bearing resistance of piles
- ☐ 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

Masonry Design

- ☐ Design methodology
- ☐ The fact that masonry can resist tension without steel!
- ☐ Brick, block, CMU, etc.
- ☐ Weathering and moisture considerations
- ☐ Grout vs. mortar
- ☐ MASONWORK
- ☐ Lintels and arching action
- ☐ Stresses in steel and masonry in flexure
- ☐ Effect of stirrups on shear strength in reinforced and unreinforced walls
- ☐ Increase in allowable stress with wind load
- ☐ Ultimate strength design with $0.80f'_m$
- ☐ h/t limit for masonry columns
- ☐ Beam-columns and interaction formulas
- ☐ Virtual eccentricity
- ☐ Design vs. analysis