

## ARCH 614. 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.

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### *Statics*

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

### *Mechanics of Materials*

- |   |  |
|---|--|
| <input type="checkbox"/> Normal stress (compression & tension)                | <input type="checkbox"/> Orthotropic vs. Isotropic vs. Anisotropic materials                           |
| <input type="checkbox"/> Shear stress (non beams)                             | <input type="checkbox"/> Creep   |
| <input type="checkbox"/> Bearing stress                                       | <input type="checkbox"/> Stress concentration  |
| <input type="checkbox"/> Bending & shear stress (beams)                       | <input type="checkbox"/> Thermal vs. elastic strains   |
| <input type="checkbox"/> Torsional (shear) stress (and where maximum occurs)  | <input type="checkbox"/> Geometric constraints   |
| <input type="checkbox"/> Relation of strain to stress & Modulus of Elasticity | <input type="checkbox"/> Dynamics vs. Statics  |
| <input type="checkbox"/> Brittle, Ductile & Semi-brittle material behavior    | <input type="checkbox"/> Serviceability  |
| <input type="checkbox"/> Yield strength (or point & proportional limit)       | <input type="checkbox"/> Deflections & elongation  |
| <input type="checkbox"/> Ultimate strength                                    | <input type="checkbox"/> Stiffness (relative to $EI/L$ through $\Delta$ , or $AE/L$ through $\delta$ ) |
| <input type="checkbox"/> Strength vs. stress                                  | <input type="checkbox"/> <i>Superpositioning</i>   |
| <input type="checkbox"/> Rupture / Fatigue behavior                           | <input type="checkbox"/> Single vs. double shear   |

*General: Beams*

- Concentrated loads
- Distributed loads – uniform / non-uniform
- Simply supported
- Overhang
- Cantilever
- Restrained
- Continuous
- $w$  vs.  $W$
- Equivalent center of load area
- Load tracing & tributary width (vs. area)
- 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
- Slope relationships with integration
- Use of Beam Diagrams and Formulas
- 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)
- Shear flow and shear center
- Connected area
- Nail capacity and pitch for resisting longitudinal shear
- Moment *redistribution* for statically indeterminate beams
- Theorem of Three Moments
- Continuous beams with pins
- Lateral buckling (and bracing)
- Lateral *torsional* buckling
- Stress types in beams
- Self-weight
- Deflections & superpositioning (+ *units*)
- Joist vs. beam vs. girder

*General: Columns*

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

*General: 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
- Diagonal tension counters and solution method
- Pinned arches and frames
- Rigid vs. non-rigid pinned frames
- Rigid frame behavior
- 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 elements vs. two-way elements
- Diaphragm
- Bearing, shear, curtain walls ...
- Framing system *choices* exist
- Openings redistribute stress (or cause concentrations) and increase deflections
- Openings should be reinforced for stresses and deflection control
- System selection and design should NOT be the last phase of design

*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
- Load types (and directions) (*like D, L, S...*)
- Load combinations
- 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
- Column stability factor,  $F_{CE}$  &  $l/d$
- Connection stresses
- Design vs. analysis
- Bolt designations
- Effective net area
- Connection types
- Single vs. double shear
- Nail load capacity charts
- Bolt capacity charts and relation to wood strengths

*Steel Design*

- Design methodologies
- Unified Design Method
- 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
- Economical selection by S or Z charts
- Use of beam moment capacity charts
- Equivalent uniform load based on maximum moment
- Slenderness criteria &  $l/r$
- $k/r$  limit for steel
- with respect to least radius of gyration*
- Compact section criteria
- Use of column load capacity charts
- 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 (composite vs. non)
- Gusset plates
- Plate girder
- Web stiffener plates
- Open web joist

*Reinforced Concrete Design*

- Constituents to make concrete
- Behavior in compression vs. tension of concrete
- Design methodology
- 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
- Reinforcement grades
- Reinforcement ratio
- Effective depth vs. depth of a beam
- Under-reinforced vs. over-reinforced
- 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
- Stirrup strength
- 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
- 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
- Why torsional shear stirrups are “closed”
- Continuous beam analysis with coefficients
- Effective column length for sway or non-sway frames
- Columns with ties vs. spirals (stresses, factors, etc.)
- Location of maximum shear in beams & footings
- Location of maximum moment in footings
- Composite decking
- Design vs. analysis

*Foundation Design*

- 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

*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
- Beam-columns and interaction formulas
- Virtual eccentricity
- Design vs. analysis