

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

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

Masonry Design

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

Foundation Design

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

Structural Supervision

- | | |
|---|--|
| <input type="checkbox"/> Steel grade | <input type="checkbox"/> Protection of timber from weather |
| <input type="checkbox"/> Concrete mix design & slump | <input type="checkbox"/> Bracing during construction |
| <input type="checkbox"/> Concrete cylinders | <input type="checkbox"/> Tolerances for assembly |
| <input type="checkbox"/> Masonry prisms | <input type="checkbox"/> Fire considerations |
| <input type="checkbox"/> Clear (of grout) cavities for moisture | |

General: Systems

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

General: Columns

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|---|---|
| <input type="checkbox"/> Stability | <input type="checkbox"/> Combined bending and compression –
<i>interaction equations or diagrams</i> |
| <input type="checkbox"/> Buckling vs. crushing | <input type="checkbox"/> P- Δ effect |
| <input type="checkbox"/> Slenderness | <input type="checkbox"/> Eccentricity |
| <input type="checkbox"/> Critical Buckling and Euler’s Formula | <input type="checkbox"/> Kern |
| <input type="checkbox"/> Effective length, K & bracing (end conditions) | |
| <input type="checkbox"/> Beam-Columns (eccentric loading) | |

Statics & Mechanics

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

General: Planning

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

General: Design

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

General: Beams

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

General: Membranes & Shells

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

General: Plates & Grids

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

Reinforced Concrete

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

General: Lateral Loads

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

Hazards Design

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

General: Connections and Tension Members

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