

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

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

Statics

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

Mechanics of Materials

- | | |
|--|---|
| <input type="checkbox"/> Scale (square-cube) effect | <input type="checkbox"/> Torsional (shear) stress (and where maximum occurs) |
| <input type="checkbox"/> Normal stress (compression & tension) | <input type="checkbox"/> Shear stress in round, rectangular, open and closed thin-walled sections |
| <input type="checkbox"/> Shear stress (non beams) | <input type="checkbox"/> Relation of strain to stress & Modulus of Elasticity |
| <input type="checkbox"/> Bearing stress | |
| <input type="checkbox"/> Bending & shear stress (beams) | |

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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