CS 136 Midterm 2 – Topics

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The material covered is from lecture 11 (ad systems) through lecture 19 (digital currencies). Privacy (lecture 20) will not be tested.

The midterm will not be an exercise in memorization, and we will provide relevant formulas for things that are not marked as “things to know well.” Any reading marked optional in NB is out of scope. The questions on the midterm will generally be a bit more straightforward than those in homeworks. The example midterm is longer than you should expect, and these kinds of example questions will be mixed with shorter questions.

The midterm will be closed book (and calculators not allowed).

The numbers below refer to chapters. Where proofs are not explicitly mentioned as out of scope, try to understand the high level idea but you would not be expected to recreate a full proof in the exam.

**Things to know well.** *You could sit down and work out things related to these concepts without hints.*

1. #10 (online advertising markets): sponsored vs contextual vs display ads, position auction model and separable value model, application of VCG (properties, working through an example), the GSP auction (design, properties, and working through a Nash equilibrium and balanced bidding on an example), statements of Thms 10.2 and 10.3 (not proofs), design tradeoffs (sec 10.5).

2. #11 (combinatorial auctions): superadditive and subadditive valuations, exposure problem, languages (OR, XOR, OR*, XOR-of-OR and OR-of-XOR) and examples, statements of Theorem 11.1, 11.2, 11.3, 11.5, proof idea for Theorem 11.1, the winner-determination problem and its IP formulation (including the idea of the NP-hardness reduction in Theorem 11.6), the VCG mechanism (properties, including shortcomings in Example 11.14).

3. #12 (matching markets): implication of Gibbard-Satterthwaite impossibility; one-sided vs. two-sided matching problems; blocking pairs, stable matching, deferred acceptance, Theorem 12.2, 12.3, 12.4, 12.5 (not proofs); the house allocation problem, serial dictatorship, random serial dictatorship, Theorem 12.6 (and proof), Theorem 12.7; the housing markets problem, a blocking coalition, a core assignment, the TTC mechanism, Theorem 12.8 and 12.9 (and proof ideas); kidney paired donation, max cardinality matching with swaps and cycles, complexity results, non-simultaneous altruistic donor chains.
4. #20 (reputation systems): moral hazard, adverse selection, the design space (and design concerns), problems with eBay reputation system, and motivations for its redesign (and efficacy of redesign).

5. ethics: basic ideas of repugnance, and the role of repugnance as a challenge to market design.

6. #17 (information elicitation): strictly proper scoring rules, the log scoring rule, affine transforms, peer prediction (PP mechanism, strictly proper definition), the output agreement mechanism (including Theorem 17.4 and the self-dominant property), Figure 17.5 and the idea of a state-based model, the 1/prior mechanism (not Theorem 17.5), and scoring-rule based peer prediction (Defn 17.9).

7. #23 (digital currencies): fiat vs gold standard, advantages and vulnerabilities of a digital currency, basic idea of the iOwe digital currency and vulnerabilities, Bitcoin (basic idea, transactions, hash functions, block and block chains, proof of work, acceptable blocks, incentives and mining coins, basic idea of the section 23.4.5 double-spending attack).

Things to be familiar with. If we wanted you to do anything especially technical we’d give some hints.

1. #10 (online advertising markets): proof idea for Theorem 10.1, Proof idea for Theorem 10.3, concept of envy-free Nash equilibria, statement Theorem 10.5, bid pacing (section 10.6.2), large-scale experimentation (10.6.3).

2. #11 (combinatorial auctions): reasoning about expressive and succinctness properties of bidding languages (Section 11.2), special cases for which the winner-determination problem is tractable (Section 11.3.3), Theorem 11.4, idea of a core outcome and bidder-optimal core point (no need to memorize equations), idea that VCG is not vulnerable to bad properties VCG1-VCG3 when the outcome is in the core.

3. #12 (matching markets): idea of proof of Theorem 12.2, ABO blood compatibility, two-sided matching practical considerations, idea of hospital incentive considerations (Section 12.4.5, but not technical details).

4. #20 (reputation systems): the reputation game (its model of a reputation system, and statement of Theorem 20.1), whitewashing (conceptual, not technical).

5. #17 (information elicitation): the quadratic scoring rule, Theorem 17.5 (no need to memorize ‘self-predicting’), Theorem 17.6 and the proof idea, concerns about uninformative equilibria (including the trick-or-treat experiment, but skipping the definition of the three-peer mechanism).

6. #23 (digital currencies): design responses to iOwe vulnerabilities (and strong vs. weak trust).

Advanced topics – Out of scope for midterm

1. #10 (online advertising markets): Theorem 10.4, proof Theorem 10.5, cookie matching (sec 10.1.4), section 10.6.1 (optimizing reserves).
2. #11 (combinatorial auctions): branch and bound, proof ideas for Theorem 11.5, section 11.5.2 onwards except for basic idea of VCG and core outlined in ‘be familiar with’

3. #12 (matching markets): proof of Theorem 12.3, proof of Theorem 12.8, proof of Theorem 12.9, Consistency (Def 12.11, Thm 12.10), Theorem 12.11.

4. #20 (reputation systems): specific details on various real world reputation systems (except for the details of eBay’s redesign), subgame-perfect analysis of reputation game, Airbnb system design (section 20.4.3).

5. #17 (information elicitation): the scoring rule characterization (Section 17.1.2), and section 17.2.5 onwards.

6. #23 (digital currencies): section 23.4.6 onwards, public key cryptography.