Read Sections 9.1, 9.2, 10.2, 10.4 through Theorem 10.33.
Skip the section on Primality (Theorem 10.6 thru Theorem 10.9) and the proof of Lemma 10.30.

1. Let $EQ_{BP} = \{\langle B_1, B_2 \rangle | B_1$ and $B_2$ are equivalent branching programs\}.
   Show that $EQ_{BP}$ is coNP-complete.

2. Let $SAT_2 = \{\langle \phi \rangle | \phi$ is a Boolean formula that has exactly two satisfying assignments\}.
   Show that $SAT_2 \in P$.

3. Describe a deterministic, polynomial-time $SAT$-oracle Turing machine $M^{SAT}$ that takes as input a directed graph $G$ and nodes $s$ and $t$, and outputs a Hamiltonian path from $s$ to $t$ if one exists. If none exist, then $M^{SAT}$ outputs No Hamiltonian path.

4. Let $ICFL$ be the class of languages that can be expressed as the intersection of two context free languages. In other words $ICFL = \{A | A = B \cap C$ for some CFLs $B$ and $C\}$.
   (a) Prove $ICFL \subseteq P$.
   (b) Prove that $P$ contains some language which is not in $ICFL$.
      (Hint: a theorem we proved in lecture is useful here.)

5. Let $EQ_{NFA} = \{\langle A, B \rangle | A$ and $B$ are NFAs and $L(A) = L(B)\}$.
   Show that $EQ_{NFA}$ is PSPACE-complete.

6. The class RP is a subset of BPP, where the probabilistic polynomial time decider never accepts for inputs outside the language, thereby exhibiting one-sided error. More formally, RP is the collection of languages $A$ for which a probabilistic polynomial time decider, accepts with probability at least $\frac{2}{3}$ (or equivalently $\frac{1}{2}$) for inputs in $A$ and accepts with probability 0 for inputs not in $A$. For example, our proof that $EQ_{ROBP} \in BPP$ actually shows that $EQ_{ROBP} \in coRP$. Prove that if $NP \subseteq BPP$ then $NP = RP$.
   (Hint: An RP machine should accept only when it is certain that its input is in the language. How can we be certain that a formula $\phi$ is satisfiable?)

7* (Optional) Suppose that $A$ and $B$ are two oracles. One of them is an oracle for TQBF, but you don’t know which. Give an algorithm that has access to both $A$ and $B$, and that is guaranteed to solve TQBF in polynomial time.

Final exam: Thursday, December 17, 2020, 3 hours, start time flexible.
It covers Chapters 1, 2 (except 2.4), 3, 4, 5, 6.1, 7, 8, 9.1, 9.2, 10.2 (except the part on Primality), and 10.4 through Theorem 10.33.