Things you must remember (or know how to derive)

Include but are not limited to:

1. Definition of bandwidth, what are low- and high-pass filters, Butterworth filters
2. Loop transfer function and closed-loop transfer functions (including their meaning, e.g., from where to where)
3. Understanding Nichols charts and M-circles
4. Bode's gain-phase relation (qualitatively, no need to remember the formula)
5. Bode's sensitivity integral
6. Pole-placement (qualitatively, no need to memorize the Sylvester matrix)
7. Strong stabilization and the parity interlacing property
8. Padé approximation of delays (only main qualitative properties of $[n, n]$-Padé, like stability and relations between its numerator and denominator, no exact formulae for coefficients; but know how to derive)
9. Loop delays and dead-time compensation (qualitatively)
10. Choice of the reference signal and S-curves
11. FIR systems and bang-bang control (qualitatively)
12. 2DOF controllers
13. Multiplicative unstructured uncertainty description and robust stability condition
14. Robust performance (qualitatively)
15. Saturation and anti-windup (qualitatively)
16. Basic linear algebra (Cayley–Hamilton, matrix functions, sign-definite matrices)
17. State-space realizations, companion and observer forms, similarity transformation
18. Cascade, parallel, feedback interconnections, inversion in state space
19. Controllability / stabilizability / observability / detectability and their tests (all of 'em), minimality
20. Relations between pole-zero cancellations and uncontrollable/unobservable modes
21. State feedback (no need to memorize the Ackerman's formula)
22. Luenberger observer, its derivation and properties
23. Observer-based feedback and the separation principle
24. LQR (but no need to memorize the Riccati equation), with main properties (return difference equality, gain/phase margins, expensive control, when is state feedback optimal)
25. Kalman filter
26. Disturbance models and their usage in state-space techniques
27. Sampled-data systems, A/D and D/A converters in time and frequency domains (aliasing, cloning, frequency response of the ZOH)
28. The Sampling Theorem
29. Digital redesign and its components; Tustin and Tustin with prewarping
30. (Step-invariant) discretization of continuous-time systems in state space
31. Pathological sampling
32. Dead-beat control

Perhaps I forgot something, so learn more to be on the safe side…

In addition, there might be questions on *deriving* the observer-based closed-loop dynamics, the LQR law, step-invariant discretization, et cetera from scratch (or almost from scratch, in LQR derivations, for example, the CARE will be provided).