Exam Topic Area: Controls

General: Questions on the exam will be thought-provoking, but can be solved with a thorough understanding of the underlined foundations of the topic area. Question difficulty will generally be at the level of challenging undergraduate material, and will often require understanding and application of multiple concepts to come to the correct solution.

Specific: Questions will test the student's ability to understand and apply fundamental principles of classical single-input, single-output (SISO) control theory. Any necessary tables and figures, plus a sheet of potentially useful equations, will be provided with the exam. *Non-programmable calculators will be provided but may not be needed.*

Reference List:

- Gene F. Franklin, J. David Powell and Abbas Emami-Naeini, "Feedback Control of Dynamic Systems, *Feedback Control of Dynamic Systems*, 7th Edition, Pearson (Chapters 1-6).
- Norman Nise, Control Systems Engineering, 7th Edition, Wiley, (Chapters 1-11*).
- Katsuhiko Ogata, *Modern Control Engineering*, 4th Edition, Prentice Hall (Chapters 1, 2, 5-9*).
- M. M. Seron, J. H. Braslavsky, and G. C. Goodwin, *Fundamental Limitations in Filtering and Control*, Spring-Verlag, 1997 (Chapters 1-3), available electronically (at, e.g. https://pdfs.semanticscholar.org/d801/065462c8e9723d79b003439dd67b5b350b57.pdf).

Questions will be drawn from the following list of topics:

- Laplace transforms and transfer functions
- Time response (transient and steady-state) of first-, second- and higher-order linear systems.
- Reduction of multiple subsystems
- Analytical investigations of stability using Routh-Hurwitz stability criteria
- Steady-state error analysis (for unity and mon-Unity feedback systems and systems with disturbances).
- PID and lead-lag Control
- Controller design using root locus techniques.
- Harmonic steady-state response to asymptotically stable transfer functions.
- Design using frequency response Techniques, including Bode and Nyquist plots.
- Basic loop-shaping for linear control system design
- Internal model principle for sinusoidal command following and disturbance rejection.

Undergraduate courses offered in this area:

Courses listed here are for your reference only and may be helpful for relearning/reviewing the material. Questions on the exam are limited by the topics list and reference list, not by the material covered in this (these) course(s):

- ME 440 – Design of Feedback Control Systems