GUJARAT TECHNOLOGICAL UNIVERSITY

BE-3 SEMESTER – OLD PAPER – S22 TO W25 – QUESTION BANK

Subject Name & Code:
Control Systems (3131101)

Unit 1 – Introduction to Control Systems

Repeated Questions:

1. **Compare open-loop and closed-loop control systems.**
   - Appeared in: S22 (Q1c, 07 marks), S24 (Q1b, 04 marks), W22 (Q1a, 03 marks), S25 (Q5a OR, 03 marks)
2. **Define: System, Input, Output.**
   - Appeared in: S24 (Q1a, 03 marks)
3. **What is a control system? Explain types of control systems.**
   - Appeared in: S22 (Q1c, 07 marks)

Other Important Questions:

1. **Explain feedback and its effects.**
   - Appeared in: S22 (Q1a, 03 marks), W24 (Q2b OR, 04 marks)
2. **Explain closed-loop system with block diagram and example.**
   - Appeared in: S23 (Q1a, 03 marks)
3. **Discuss the effect of feedback on sensitivity.**
   - Appeared in: W22 (Q5a OR, 03 marks)

Unit 2 – Mathematical Models of Systems

Repeated Questions:

1. **Define transfer function. State its properties.**
   - Appeared in: S22 (Q1b, 04 marks), S22 (Q2a, 03 marks), S23 (Q1c, 07 marks), W23 (Q1a, 03 marks), W24 (Q5a, 03 marks)
2. **Explain block diagram reduction rules with examples.**
   - Appeared in: S24 (Q2c OR, 07 marks), S23 (Q3c, 07 marks), W23 (Q1c, 07 marks), W25 (Q1c, 07 marks), W22 (Q4b, 04 marks)
3. **Compare block diagram and signal flow graph methods.**
   - Appeared in: S22 (Q2b, 04 marks), W23 (Q1b, 04 marks)

Other Important Questions:

1. **Find Laplace transform of sin(wt), cos(2t), sinh(4t), etc.**
   - Appeared in: S24 (Q2b, 04 marks), W25 (Q4a, 03 marks), S25 (Q3b, 04 marks)
2. **Determine transfer function of given electrical/mechanical system.**
   - Appeared in: S24 (Q2c, 07 marks), S22 (Q2c OR, 07 marks), W24 (Q3c, 07 marks)
3. **Explain Mason's gain formula with example.**
   - Appeared in: S25 (Q5b, 04 marks), W25 (Q2c, 07 marks), W22 (Q2c OR, 07 marks)

Unit 3 – Feedback Control System Characteristics

Repeated Questions:

1. **Define steady-state error and derive static error coefficients.**
    - Appeared in: S23 (Q3b, 04 marks), S25 (Q4c, 07 marks), W22 (Q1c, 07 marks), W23 (Q2b, 04 marks), W24 (Q3b, 04 marks)
2. **Explain force-voltage (F-V) and force-current (F-I) analogies.**
    - Appeared in: S23 (Q1b, 04 marks), S24 (Q3c, 07 marks), S25 (Q1b, 04 marks), W24 (Q3b, 04 marks), W25 (Q3b, 04 marks), W22 (Q1b, 04 marks)

Other Important Questions:

1. **Define: Type and order of system.**
    - Appeared in: S24 (Q3a OR, 03 marks)
2. **Derive expression for steady-state error and static error coefficients.**
    - Appeared in: S25 (Q4c, 07 marks)
3. **Discuss effect of feedback on time constant.**
    - Appeared in: W24 (Q3a, 03 marks)

Unit 4 – The Performance of Feedback Control Systems

Repeated Questions:

1. **Explain standard test signals.**
    - Appeared in: S24 (Q3b, 04 marks), S25 (Q3a, 04 marks), W25 (Q1a, 03 marks), W23 (Q5a, 03 marks), S22 (Q3b, 04 marks)
2. **Define: Settling time, peak time, peak overshoot, delay time, rise time.**
    - Appeared in: S24 (Q4a OR, 03 marks), S25 (Q1a, 03 marks), W24 (Q3a OR, 03 marks), S22 (Q3b, 04 marks), W22 (Q4a, 04 marks)
3. **Derive expressions for rise time, peak time, peak overshoot for second-order system with unit step input.**
    - Appeared in: S25 (Q1c, 07 marks), W24 (Q2c, 07 marks), W23 (Q2c OR, 07 marks), W22 (Q5b, 04 marks), S22 (Q5a, 03 marks)

Other Important Questions:

1. **Derive unit step response of first-order system.**
    - Appeared in: W25 (Q5c, 07 marks), W24 (Q2a OR, 03 marks), W22 (Q2b, 04 marks)
2. **Discuss impulse response of second-order system.**
    - Appeared in: W25 (Q5c OR, 07 marks)
3. **Discuss unit step response of second-order system for $\xi > 0$.**
    - Appeared in: S23 (Q2c, 07 marks)
4. **Define: Undamped system, damped frequency of oscillation, natural frequency of oscillation.**
    - Appeared in: S24 (Q4a, 03 marks)

Unit 5 – The Stability of Linear Feedback Systems

Repeated Questions:

1. **Explain Routh-Hurwitz stability criterion.**
    - Appeared in: S24 (Q4b, 04 marks), S25 (Q2a, 03 marks), W24 (Q2a, 03 marks), W23 (Q4a, 03 marks)
2. **Define: Conditionally stable system, unstable system, marginally stable system.**
    - Appeared in: S24 (Q5a, 03 marks), S25 (Q4a, 03 marks)
3. **Analyze necessary conditions for Hurwitz criterion.**
    - Appeared in: S24 (Q4b, 04 marks)

Other Important Questions:

1. **Apply Routh-Hurwitz to determine stability of given characteristic equation.**
    - Appeared in: S23 (Q5c OR, 07 marks), W22 (Q3b, 04 marks), W23 (Q3c, 07 marks)
2. **Define: Absolute stability, relative stability.**
    - Appeared in: W22 (Q4a OR, 03 marks), S23 (Q5a, 03 marks)
3. **Explain Hurwitz stability criteria.**
    - Appeared in: S22 (Q3a OR, 03 marks)

Unit 6 – The Root Locus Method

Repeated Questions:

1. **State/sketch root locus rules/plot for $G(s) = \frac{K}{s(s+2)(s+4)}$.**
   - Appeared in: S24 (Q4c, 07 marks), S25 (Q2c OR, 07 marks)
2. **Explain steps/rules of root locus construction.**
   - Appeared in: S24 (Q4c OR, 07 marks), S25 (Q2c, 07 marks), W24 (Q4c, 07 marks), W23 (Q4c, 07 marks)
3. **Define: Centroid, root locus concept.**
   - Appeared in: S23 (Q4a, 03 marks), S22 (Q3a, 03 marks), W23 (Q3a, 03 marks)

Other Important Questions:

1. **Sketch root locus for given open-loop transfer function (e.g., $G(s)H(s) = \frac{K(s+12)}{s^2(s+20)}$).**
   - Appeared in: W23 (Q4c, 07 marks)
2. **Find value of K for given damping ratio from root locus.**
   - Appeared in: S24 (Q4c, 07 marks)
3. **For type-2 system, find root locus and comment on stability.**
   - Appeared in: S22 (Q4c, 07 marks)
4. **Sketch root locus for unity feedback system with $G(s) = \frac{k}{s(s+2)}$.**
   - Appeared in: S23 (Q5c, 07 marks)

Unit 7 – Frequency Response Methods

Repeated Questions:

1. **Define: Gain margin, phase margin, cut-off frequency, phase/gain crossover frequency.**
   - Appeared in: S24 (Q5a OR, 03 marks), S25 (Q5a, 03 marks), W24 (Q4a, 03 marks), W25 (Q5a OR, 03 marks), W22 (Q4a OR, 03 marks), W23 (Q5b, 04 marks)
2. **Explain steps to sketch Bode plot.**
   - Appeared in: S24 (Q5b, 04 marks), S25 (Q2b, 04 marks), W24 (Q5b OR, 04 marks)
3. **Explain polar plot with example.**
   - Appeared in: S25 (Q4b OR, 04 marks), W25 (Q4b OR, 04 marks), W24 (Q5b, 04 marks), S23 (Q3a OR, 03 marks), W22 (Q3a, 03 marks)

Other Important Questions:

1. **Draw Bode plot for given transfer function (e.g., $G(s) = \frac{80}{s(s+2)(s+20)}$).**
   - Appeared in: S24 (Q5c, 07 marks)
2. **Discuss nature of Bode plot for poles/zeros at origin.**
   - Appeared in: W25 (Q3c OR, 07 marks)
3. **Explain frequency response, its applications, and limitations.**
   - Appeared in: S23 (Q4b, 04 marks)
4. **Define: Resonant peak, resonant frequency, bandwidth.**
   - Appeared in: S23 (Q2a, 03 marks)
5. **List properties of M-circles.**
   - Appeared in: S23 (Q3a, 03 marks), W23 (Q4b, 04 marks)
6. **Draw Bode plot for $G(s) = \frac{100}{s(1+0.5s)(1+0.1s)}$.**
   - Appeared in: W22 (Q3c OR, 07 marks)

Unit 8 – The Design of Feedback Control Systems

Repeated Questions:

1. **Explain P, PI, PID, PD controllers.**
    - Appeared in: S24 (Q5c, 07 marks), S25 (Q3c, 07 marks), W25 (Q3a, 03 marks), W24 (Q5a OR, 03 marks), W22 (Q5a, 03 marks), W23 (Q3b, 04 marks)
2. **Explain phase-lag and phase-lead compensators in detail.**
    - Appeared in: S25 (Q5c, 07 marks), S25 (Q5c OR, 07 marks), W25 (Q4c, 07 marks), W25 (Q4c OR, 07 marks), W24 (Q5c, 07 marks), S23 (Q4c, 07 marks), W22 (Q5b OR, 04 marks), W22 (Q4c OR, 07 marks)

Other Important Questions:

1. **Obtain transfer function of lag/lead compensator.**
    - Appeared in: S23 (Q4c, 07 marks)
2. **Explain compensator concept.**
    - Appeared in: S25 (Q5c, 07 marks)
3. **Discuss steps to design lag compensator using Bode plot.**
    - Appeared in: W22 (Q4c OR, 07 marks)

Unit 9 – Stability in the Frequency Domain

Repeated Questions:

1. **Explain Nyquist stability criterion.**
   - Appeared in: S25 (Q4b, 04 marks), W24 (Q2b, 04 marks), W23 (Q2a, 03 marks), W23 (Q4a, 03 marks), S22 (Q5c, 07 marks)
2. **Draw Nyquist plot for given transfer function and determine stability.**
   - Appeared in: W23 (Q5c, 07 marks), W22 (Q2c, 07 marks)

Other Important Questions:

1. **How are gain and phase margin obtained from Nyquist plot?**
   - Appeared in: W25 (Q4b, 04 marks)
2. **Draw Nyquist contour and plot for $G(s)H(s) = \frac{s+2}{s^2-1}$.**
   - Appeared in: S22 (Q5c OR, 07 marks)
3. **Draw polar plot for $G(s) = \frac{40}{s^2(s+4)}$.**
   - Appeared in: S22 (Q4c OR, 07 marks)
4. **Consider $G(s)H(s) = \frac{10}{s}$, obtain polar plot.**
   - Appeared in: S24 (Q5b OR, 04 marks)

Unit 10 – State Variable Models

Repeated Questions:

1. **Define: State, state variable, state vector, state trajectory.**
   - Appeared in: S24 (Q3a, 03 marks), W25 (Q5a, 03 marks), W23 (Q5a, 03 marks), S22 (Q4a OR, 03 marks)
2. **Write advantages of state space analysis over classical methods.**
   - Appeared in: S25 (Q4a OR, 03 marks), W25 (Q2a, 03 marks), W22 (Q3b OR, 04 marks), W23 (Q5b OR, 04 marks)
3. **Derive state variable equations $\dot{X} = AX + BU$, $Y = CX + DU$ and draw block diagram/state diagram.**
   - Appeared in: W23 (Q5c, 07 marks), W22 (Q5c OR, 07 marks)

Other Important Questions:

1. **Explain correlation between transfer function and state space equations.**
   - Appeared in: S23 (Q4a OR, 03 marks), S22 (Q5a OR, 03 marks)
2. **Write short note on state space representation of control system.**
   - Appeared in: S23 (Q5b, 04 marks), W25 (Q2c OR, 07 marks), W24 (Q5c OR, 07 marks), W22 (Q5c, 07 marks)
3. **Obtain state transition matrix for given system matrix.**
   - Appeared in: W22 (Q3c, 07 marks)
4. **Describe state differential equation, signal-flow graph, and block diagram models.**
   - Covered in syllabus; implied in questions on modeling.

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