$\frac{46}{65} = 71\%$

65

16.060 Quiz
November 20, 2001

1. Develop a state space model and determine the A, B, C and D matrices for each of the following systems 8/10

a) $$G(s) = \frac{1}{(s^2 + s + 4)}$$

b) $$G(s) = \frac{(s+1)}{(s^2 + s + 4)}$$

c) $$G(s) = \frac{(s^2+1)}{(s^2 + s + 4)}$$

2. Given the following state space system 10/10

$$A = \begin{bmatrix} -3 & -1 \\ -2 & -4 \end{bmatrix} \qquad B = \begin{bmatrix} 1 \\ 1 \end{bmatrix} \qquad C = \begin{bmatrix} 2 & 3 \end{bmatrix} \qquad D = [0]$$

a) Determine its stability

b) Determine its input/output transfer function

3. Determine the state transition matrix for a state space system with the following A matrix 8/10

$$A = \begin{bmatrix} 0 & 2 \\ -2 & 0 \end{bmatrix}$$

4. For the following state space system -1 8/10

$$A = \begin{bmatrix} 0 & 1 \\ 0 & -2 \end{bmatrix} \qquad B = \begin{bmatrix} 0 \\ 1 \end{bmatrix} \qquad C = \begin{bmatrix} 1 & 1 \end{bmatrix} \qquad D = [0]$$

determine the output response to a unit step input and the following initial conditions

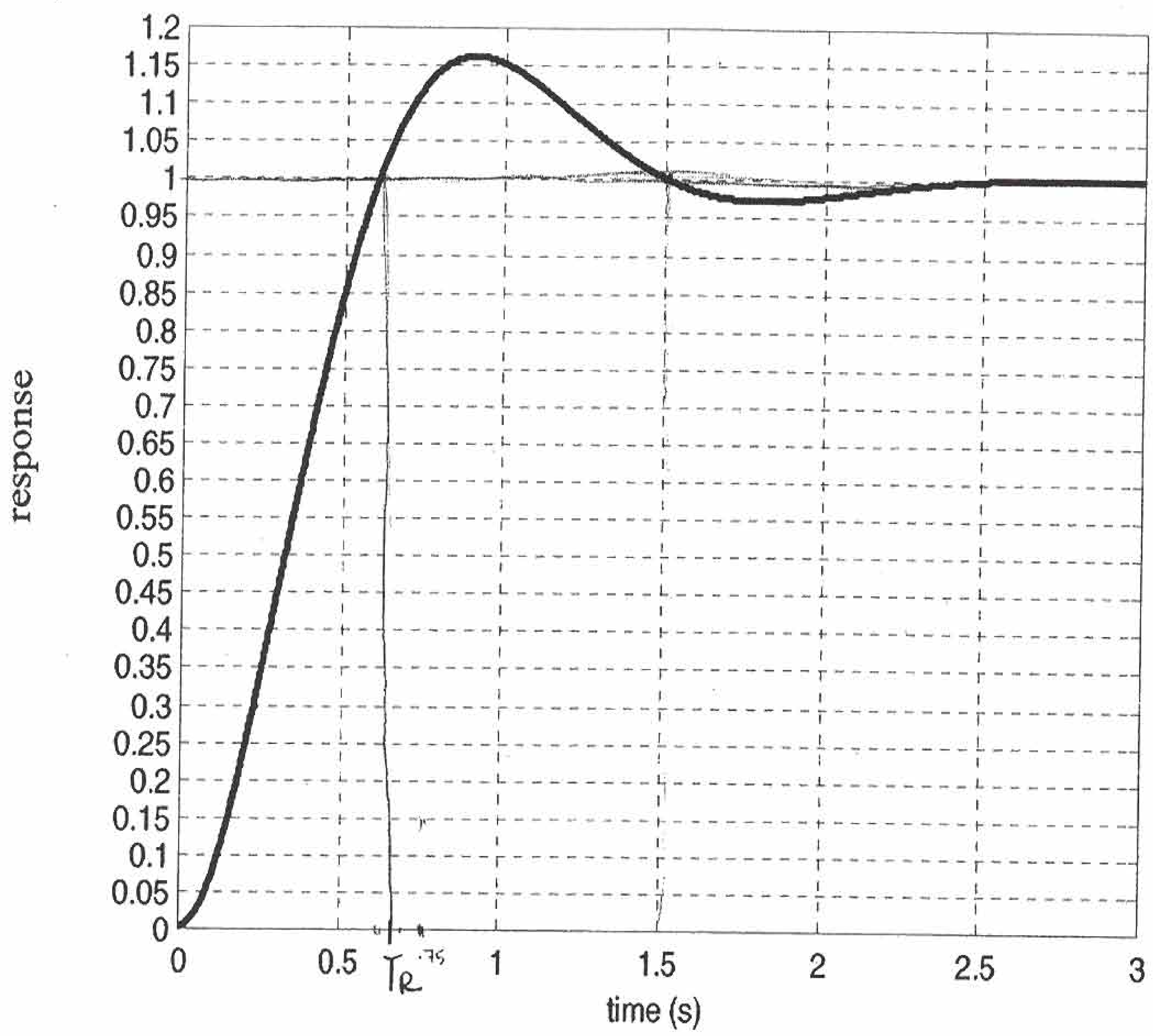
$$\underline{x}(0) = \begin{bmatrix} 0 \\ 0 \end{bmatrix}$$

5. A second-order open-loop system is subjected to a unity step input. The response is shown below. The percentage overshoot is 16.3% and the time to peak is 0.908s.

3/6

a) Calculate
   i. The damping ratio, ζ (hint: use the data on the following page)
   ii. The damped natural frequency, ω_d

b) What are the open-loop poles of the system?



c) Design a PD compensator which, when used in a unity feedback closed-loop system will yield closed-loop poles at

$$s = -3.46 \pm j3.46$$

T = 0.908

6. What value(s) of the constant c will make following state space system uncontrollable?

3/5

$$A = \begin{bmatrix} -1 & 1 \\ 1 & c \end{bmatrix} \qquad B = \begin{bmatrix} 1 \\ -1 \end{bmatrix}$$

7. Determine a full state feedback matrix K for the following system

8/10

$$A = \begin{bmatrix} 0 & 1 & 0 \\ -2 & 0 & 1 \\ -1 & 0 & 0 \end{bmatrix} \qquad B = \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix} \qquad C = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix} \qquad D = \begin{bmatrix} 0 \\ 0 \\ 0 \end{bmatrix}$$

so that the closed loop system has poles at +3j,-3j, and -4