

## M.E. DEGREE EXAMINATIONS: OCTOBER/NOVEMBER 2008

Second Semester

## APPLIED ELECTRONICS

## P07AE203: Digital Control Engineering

Time: Three Hours

Maximum Marks: 100

Answer ALL Questions:-

## PART A (20 × 2 = 40 Marks)

- The maximum peak-overshoot  $M_p$  of a second order system when subjected to a unit step input is given by
  - $(e^{-\zeta\pi})/\sqrt{1-\zeta^2}$
  - $\sqrt{1-\zeta^2}(e^{-\zeta\pi})$
  - $e^{(-\zeta\pi/\sqrt{1-\zeta^2})}$
  - $(e^{-\sqrt{1-\zeta^2}})/\zeta\pi$
- The steady-state error of a type-I system subjected to a unit ramp input is given by
  - $T$
  - $1/T$
  - $\infty$
  - Zero
- The phase lead compensators are used to improve
  - the transient response
  - the steady-state response
  - both transient and steady state responses
  - the dynamic error coefficients
- With integral controller
  - peak-overshoot increases
  - peak-time reduces
  - the steady state-error eliminated
  - the settling time reduces
- The transfer function of a first-order hold circuit is
  - $\left(\frac{1-e^{-sT}}{s}\right)\frac{Ts+1}{T}$
  - $\left(\frac{1-e^{-sT}}{s^2}\right)\frac{Ts+1}{T}$
  - $\left(\frac{1-e^{-sT}}{s}\right)^2\frac{Ts+1}{T}$
  - $\left(\frac{1-e^{-sT}}{s}\right)\frac{Ts+1}{T^2}$
- Which of the following represents the frequency domain representation of a Zero-order hold
  - $G_{ho}(j\omega) = T\frac{\sin(\omega T/2)}{\omega T/2} e^{-(1/2)Tj\omega}$
  - $G_{ho}(j\omega) = T\frac{\omega T/2}{\sin(\omega T/2)} e^{-(1/2)Tj\omega}$
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  - $G_{ho}(j\omega) = \frac{\sin(\omega T/2)}{\omega T/2} e^{-(1/2)Tj\omega}$
- One of the conditions of Jury's stability test is
  - $P(z)|_{z=1} > 0$
  - $P(z)|_{z=1} = 0$
  - $P(z)|_{z=1} < 0$
  - $P(z)|_{z=1} \neq 0$
- In digital control the Static Velocity Error Constant is given by
  - $K_v = \lim_{z \rightarrow 1} \frac{(1-z^{-1})^2 GH(z)}{(1-z^{-1})^T GH(z)}$
  - $K_v = \lim_{z \rightarrow 1} \frac{(1-z^{-1})^2 GH(z)}{T^2}$
  - $K_v = \lim_{z \rightarrow 1} \frac{(1-z^{-1})^2 GH(z)}{T}$
  - $K_v = \lim_{z \rightarrow 1} \frac{(1-z^{-1})^2 GH(z)}{T}$

18. If  $-\alpha + j\beta$  is the desired pole of the digital controller then the sampling frequency  $T$  is limited by the relation

a.  $-\alpha + j\beta = \frac{z-1}{T}$

c.  $-\alpha + j\beta = \frac{T}{z-1}$

b.  $-\alpha + j\beta = \frac{z+1}{T}$

d.  $-\alpha + j\beta = \frac{T}{z+1}$

19. The quantization level  $Q$  of a analog-to-digital converter is given by

a.  $\frac{FSR}{2^n}$

c.  $\frac{FSR}{2n}$

b.  $\frac{FSR}{2^{n-1}}$

d.  $\frac{FSR}{2n-1}$

where  $FSR$  denotes full-scale range and  $n$ , number of output bits.

20. The a microcontroller based digital control system the sampling frequency is decided by

- a. The maximum frequency component of the system alone.
- b. The maximum operating frequency of the microcontroller.
- c. Both a and b.
- d. The average of the frequency components of the system.

**PART B (5 × 16 = 80 Marks)**

21. (a) (i) Derive the pulse transfer function of a Digital PID controller. (10)

(ii) State the need of compensators in control system design. (6)

(OR)

21. (b) (i) State the frequency and time domain specifications and discuss how they are correlated with each other. (8)

(ii) Draw the electrical equivalent of phase-lead and phase-lag compensator networks along with their frequency domain characteristics and state where they are needed. (8)

22. (a) (i) Write notes on folding and aliasing. (6)

(ii) Derive the transfer function of a first-order hold circuit. (10)

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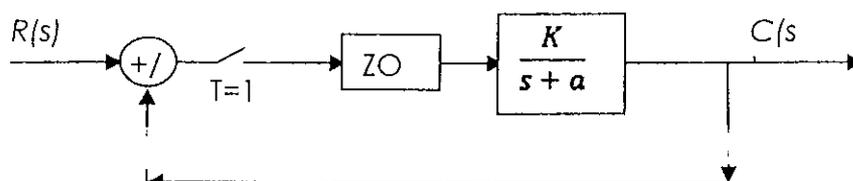
22. (b) (i) Draw the circuit diagram of a sample-and-hold circuit with its frequency domain characteristic curves and explain its operation. (10)

(ii) Derive the transfer function of zero-order hold circuit. (6)

23. (a) (i) Determine the stability of the following discrete system. (8)

$$\frac{Y(z)}{U(z)} = \frac{z^{-3}}{1 + 0.5z^{-1} - 1.34z^{-2} + 0.24z^{-2}}$$

(ii) Obtain the closed-loop pulse transfer function of the following system. (8)



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