Code: 9A13801

1

B. Tech IV Year II Semester (R09) Regular Examinations, March/April 2013

ADAPTIVE CONTROL SYSTEMS

(Electronics & Control Engineering)

Time: 3 hours Max. Marks: 70

Answer any FIVE questions

All questions carry equal marks

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1 (a) Explain the concept of adaptive control and types of adaptivity.
(b) Discuss about the effects of process variation and control essentials in brief.

2 (a) Explain the statistical interpretation of least square estimation.
(b) Write about recursive least squares with exponential forgetting.

3 (a) Compare explicit and implicit self tunning regulators.
(b) Explain minimum degree pole placement design with an algorithm.

4 Consider an integrator with a time delay τ. For the sampling period $h > \tau$, the system is given by the following equations:
$A(q) = q(q-1)$
$B(q) = (h-\tau)q + \tau = (h-\tau)(q+b)$
Where $b = \tau/(h-\tau)$ and $d_0 = 1$
The noise is assumed to be characterized by $C(q) = q(q+c);\ |c| < 1$. Compute the optimal minimum variance controller and the least attainable output variance when
(a) $\tau = 0.4$ (the minimum phase)
(b) $\tau = 0.6$ (the non-minimum phase)

5 (a) Explain Lyapunov stability analysis.
(b) What is Lyapunov function? Explain the methods for constructing Lyapunov functions.

6 (a) Draw the block diagram of an MRAS for adjustment of a feed forward gain based on MIT rule.
(b) Explain the properties of adaptive systems involved in it.

7 (a) Prove that $P = \int_0^{T/2} e^{As}\, ds\, B$
Where, A is system matrix, B is input matrix, T is limit cycle period in a linear system with relay control.
(b) Derive the equation for pulse transfer function obtained in sampling the system having relay oscillations.

8 (a) Explain the block diagram of gain scheduling.
(b) Explain the design considerations of gain scheduling controllers.

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Answer any FIVE questions

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1 Explain at least two different approaches for design of adaptive control.

2 Consider the following system with two inputs and two outputs:

$$\frac{dx}{dy} = \begin{bmatrix} -1 & 0 & 0 \\ 0 & -3 & 0 \\ 0 & 0 & -1 \end{bmatrix} x + \begin{bmatrix} 1 & 0 \\ 0 & 2 \\ 0 & 1 \end{bmatrix} u$$

$$y = \begin{bmatrix} 1 & 1 & 0 \\ 0 & 1 & 0 \end{bmatrix} x$$

Assume that proportional feedback is introduced around the second loop $u_2 = -k_2 y_2$. Determine the transfer function from u_1 to y_1 and determine how the steady state gain depends on k_2.

3 (a) Explain about indirect self tuners.
(b) Explain STR with the help of a block diagram.

4 Consider a process $G(s) = \frac{1}{s(s+a)}$; where 'a' is an unknown parameter. Assume that the desired closed loop system is $G_m(s) = \frac{\omega^2}{s^2+2\delta\omega s+\omega^2}$. Construct continuous and discrete time STR algorithms for the system.

5 (a) Explain the concept of BIBO stability.
(b) State and prove the small gain theorem.

6 Consider an MRAS for adjustment of feed forward gain based on MIT rule. Let the command signal be $u_c = a_1 \sin \omega_1 t + a_2 \sin \omega_1 t$ and assume that the process has the transfer function $G(s) = \frac{1}{(s+1)^3}$. Derive the conditions for the closed loop system to be stable.

7 (a) Explain in detail about auto tuning techniques.
(b) What are the transient response methods?

8 (a) Describe gain scheduling.
(b) Explain the working principle of gain scheduling.

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3

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ADAPTIVE CONTROL SYSTEMS

(Electronics & Control Engineering)

Time: 3 hours Max. Marks: 70

Answer any FIVE questions

All questions carry equal marks

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1 (a) Define the adaptive control problem.
(b) Explain the adaptive control system of the nuclear reactor control system.

2 (a) Explain briefly the recursive least squares estimation.
(b) Differentiate between recursive least square estimation and extended least square estimation.

3 (a) Explain pole placement design procedure for self tuning regulator.
(b) Explain about indirect self tuners.

4 (a) Explain indirect LQG-STR algorithm based on spectral factorization.
(b) Explain about indirect LQG-STR algorithm based on Ricatti equation.

5 Explain how Lyapunov stability theory can be used to construct algorithms for adjusting parameters in adaptive systems.

6 Explain how the MIT rule is used to obtain a simple adaptive controller with an example.

7 (a) Explain the Zeiger-Nichols closed loop method.
(b) Write about auto tuning techniques.

8 (a) Gain scheduling can be regarded as adaptive controllers. Justify.
(b) Gain scheduling can be used to compensate non-linearities. Discuss.

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4

B. Tech IV Year II Semester (R09) Regular Examinations, March/April 2013

ADAPTIVE CONTROL SYSTEMS

(Electronics & Control Engineering)

Time: 3 hours Max. Marks: 70

Answer any FIVE questions

All questions carry equal marks

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1 (a) Explain the different configurations of adaptive control schemes.
(b) Explain in detail about dual control.

2 (a) Discuss about geometric interpretation of least square estimate.
(b) Explain any two of FIR models in detail.

3 (a) Explain about unification of direct self tuning regulators.
(b) Explain about self tuning feed forward control.

4 (a) Explain about stochastic approximation algorithm.
(b) Define random, periodic, pulse and step signals in stochastic process.

5 State and prove Lyapunov theorems for time variant and time invariant systems.

6 Explain the following:
(a) Design parameters of MRAS.
(b) MIT rule.

7 (a) Explain about the properties of auto relay tuner with an example.
(b) Discuss about closed loop method based on relay feedback.

8 Write a short notes on the following:
(a) Parsevdl's theorem
(b) Positive real transfer function
(c) Certainty equivalence principle
(d) Hyper state

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