Sixth Semester B. Tech Degree Examination, May / June 2014
(2013 Scheme)
Branch: Chemical Engineering
13.604 Process Dynamics and Control (H)

Time: 3 Hours Max. Marks: 100

PART – A

Answer all questions. Each question carries 2 marks.

1. List the desirable properties of a thermocouple.
2. Define manipulated variable, load variable, set point and controlled variable with respect to process control system.
3. List the objectives of chemical process control.
4. Differentiate between Interacting and Non Interacting Systems.
5. Show that decay ratio = $(\text{overshoot})^2$ for a second order system with step response.
6. Define Laplace transform. Using the definition, find the Laplace transform of exponential function.
7. Define stability based on the roots of the characteristic equation.
8. With the help of a block diagram, explain various elements in a typical negative feedback control system.
9. Differentiate Gain margin and Phase margin.
10. Explain the terms dead time and dead time compensation.

PART – B

Answer **any one** full question from **each** Module.

Module – I

11. a) Derive the input – output model for a stirred tank heater? **(10 marks)**
    b) What are the various forcing functions used to study the dynamic response of a system? Explain with neat sketches. **(10 marks)**

OR

12. a) With suitable examples from chemical processes, differentiate SISO and MIMO systems? **(8 marks)**
    b) Differentiate between feedback and feed forward control strategies. Develop a feedback control and feed forward control systems for controlling the temperature of liquid inside the stirred tank, which is heated by steam passing through the steam coil immersed inside the tank. Identify different variables involved in the process. **(12 marks)**

Module - II

13. a) Consider a second order system with the following transfer function?

$$G(s) = \frac{Y(s)}{X(s)} = \frac{1}{(s^2 + s + 1)}$$

Introduce a step change of magnitude one into the system and find (i) % overshoot, (ii) decay ratio, (iii) rise time, (iv) ultimate value of Y(t). **(12 marks)**

b) Establish the time response for unit step change in input for a first order process described by the transfer function

$$G(s) = \frac{1}{(1 + \tau_p s)}$$

(8 marks)

OR

14. a) Derive the transfer function of two interacting liquid level tanks connected in series. **(10 marks)**

b) Solve the Laplace transform

$$\frac{d^2x}{dt^2} + 3\frac{dx}{dt} + 6x = 0,\ x(0) = 0,\ x'(0) = 3.$$

(10 marks)

Module - III

15. a) Determine the range of K for stability of the system with following characteristic equation

$$s^4 + Ks^3 + s^2 + s + 1 = 0$$

(10 marks)

b) Determine the stability by Routh criterion for the system with following characteristic equation

$$s^4 + 3s^3 + 5s^2 + 4s + 2 = 0$$

(10 marks)

OR

16. Draw the root locus of the system, $G(s) = \frac{1}{(s+1)(s+2)}$, controller $G_c(s) = K_c$. for what value of K_c, the system is stable? Indicate the range of K_c to yield (i) over damped (ii) critically damped and (iii) under damped closed loop responses. **(20 marks)**

Module - IV

17. Determine the controller settings for P, PI and PID controllers for the given process using Zeigler – Nichols rules.

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

(20 marks)

OR

18. Write short notes on:
    a) Smith predictor control
    b) Adaptive control
    c) Ratio control and
    d) Inferential control **(20 marks)**

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