A   **Reg. No. :** ☐☐☐☐☐☐☐☐☐☐☐☐

Question Paper Code: 56903

B.E. / B.Tech. DEGREE EXAMINATION, NOV 2019

Sixth Semester

Chemical Engineering

15UCH603 - PROCESS INSTRUMENTATION DYNAMICS AND CONTROL

(Regulation 2015)

Duration: Three hours   Maximum: 100 Marks

Answer ALL Questions

PART A - (10 x 1 = 10 Marks)

1. Which of the following category of instruments does Calipers, micrometers,   CO1- R
   scales, measuring tapes, lasers come under

   (a) Mechanical   (b) Electrical   (c) Electronic   (d) Absolute

2. _____ is used for the measurement of moisture in gases.   CO1- R

   (a) Psychrometer   (b) pH meter   (c) Pirani gauge   (d) Sonometer

3. Given a differentiable function f defined near a, the linearization of f at a is the   CO2-
   linear function given by L(x) =   R

   (a) $f(a) + \dot{f}(a)(x - a)$ (b) $f(a) + \dot{f}(a)(x + a)$ (c)) $f(a) + f(a)(x - a)$ (d) $f(a) + \dot{f}(a)(x + a)$

4. If the step response of a second-order system is critically damped, the value   CO2-
   of damping coefficient (ζ) is _____.   R

   (a) < 1 (b) > 1 (c) Infinity   (d) 1

5. The controller that continuously detects the difference between a process   CO3- R
   measurement and its set-point, and produces an output air signal of 3 to 15 psi
   .

   (a) Electronic   (b) Electrical   (c) Pneumatic   (d) Hydraulic

6. The output signal from proportional controller is directly proportional to   CO3- R

   (a) Offset   (b) Rise time   (c) Error   (d) Static gain

7. The Process Reaction Curve method of tuning is otherwise called   CO4- R

   (a) Cohen Coon   (b) Ziegler Nicholas   (c) Tyreus-Luyben   (d)Quarter

8. Routh test cannot be used to test the stability of a control system containing _____.   CO4- R

   (a) Transportation lag   (b) Phase margin   (c) Overshoot   (d) Decay ratio

9. Choose the control configuration that measures the disturbance directly and takes control action to eliminate its impact on the process output   CO5- R

   (a) Feedback   (b) Feed forward   (c) Cascade   (d) Ratio

10. An example for mass storage device in computer control system is ___.   CO5- R

   (a) Printers   (b) Magnetic tapes   (c) Registers   (d) Card reader

PART – B (5 x 2= 10 Marks)

11. List the classification of various measuring instruments.   CO1- R

12. Obtain the Laplace transform of $f(t) = R\ u(t) + L\dfrac{du(t)}{dt}$ CO2- U

13. Define the terms Rise time and Settling time.   CO3- R

14. Write any two practical significance of the gain margin.   CO4- U

15. Write notes about smith predictor control strategy.   CO5- R

PART – C (5 x 16= 80 Marks)

16. (a) List and explain each of the static characteristics of measuring instruments.   CO1- U   (16)

Or

   (b) (i) Discuss the principle of operation for Calomel reference electrode towards pH measurement.   CO1- U   (8)
      (ii) Explain the principle of viscosity measurement for solutions with a neat sketch.   CO1- U   (8)

17. (a) A mercury thermometer having a time constant of 0.1 min is placed in a temperature bath at 100°F and allowed to come to equilibrium with the bath. At time $t =0$, the temperature of the bath begins to vary sinusoidally about its average temperature of 100°F with an amplitude of 2°F. If the frequency of oscillation is 10/ p cycles/min, plot the ultimate response of the thermometer reading as a function of time. Analyze the phase lag.   CO2- Ana   (16)

Or

   (b) (i) Derive the transfer function of a process containing transportation lag.   CO2- Ana   (8)

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(ii) A step change of magnitude 4 is introduced into a system having the transfer function CO2- Ana (8)

$$\frac{Y(s)}{X(s)} = \frac{10}{s^2 + 1.6\,s + 4}$$

Determine: percent overshoot, rise time, period of oscillation and maximum value of Y(t).

18. (a) A unity feedback control system has an open loop transfer function $G(s) = \frac{5}{s(s+1)}$. Find the rise time, peak overshoot, peak time, settling time for a step input of 10 units. CO3- App (16)

Or

(b) (i) What is block diagram? Explain the major components of a block diagram. CO3- Ana (8)

(ii) . A unity feedback system is characterized by an open loop transfer function $G(s) = \frac{k}{s(s+2)(s+4)}$. Determine the gain k so that the system will have a damping ratio of 0.5. For this value of k, determine peak overshoot and peak time for a unit step. CO3- App (8)

19. (a) Draw the Bode diagram of the transfer function $(s) = \frac{5(1+3s)}{s(s^3+0.4s+1)}$. Also comment on the stability of the system. CO4- U (16)

Or

(b) (i) Explain the steps of Routh test for checking the stability of a control system. CO4- U (10)

(ii) Describe the control system design procedure using Bode stability criterion. CO4- U (6)

20. (a) Explain how smith predictor is used as dead-time compensating tool in chemical processes. CO5- Ana (16)

Or

(b) Discuss the various control strategies implemented for the control of distillate and residue composition in a distillation column. CO5- Ana (16)