Name : .....

Roll No. : .....

Invigilator's Signature : .....

CS/B.Tech (BT-NEW)/SEM-6/CHE-615/2010

2010

PROCESS INSTRUMENTATION & CONTROL

Time Allotted : 3 Hours *Full Marks :* 70

The figures in the margin indicate full marks.

Candidates are required to give their answers in their own words as far as practicable.

GROUP – A

(Multiple Choice Type Questions)

1. Choose the correct alternatives for any *ten* of the following : $10 \times 1 = 10$

   i) Macleod gauge is used to measure

      a) pressure b) vacuum

      c) flow rate d) temperature.

   ii) The transfer operation of the first order system is

      a) $1/T_S + 1$

      b) $1/T_S$

      c) $S/T_S + 1$

      d) None of these.

iii) Which of the following is not a mechanical pressure sensing element ?

a) U-tube b) Burdon tube

c) Diaphragm d) Bellons.

iv) Error caused by the act of measurement on the physical system being tested is

a) Hysteresis error b) Random error

c) Systematic error d) Loading error.

v) Optical pyrometer is used to measure the temperature of

a) furnace

b) low temperature

c) moderate temperature

d) liquid.

vi) Ratio control system is a special type of

a) open loop system

b) feedback system

c) on-off system

d) feed forward system.

vii) In proportional-plus-integral control action, time required for oscillations to stop is

a) larger b) considerable

c) shortest d) none of these.

viii) The Laplace transform of sin$t$ is

a) $1/S^2+1$

b) S/S^2+1

c) $1/S^2-1$

d) S/S^2-1.

ix) The frequency at which the maximum amplitude ratio is attained is known as

a) resonant frequency

b) radian frequency

c) corner frequency

d) cross-over frequency.

x) Which has maximum offset in P, $P-I$, $P-D$, PID controller ?

a) P b) PID

c) PD d) PI.

xi) Repeatability of the instrument with respect to a given fixed input is

a) accuracy b) precision

c) systematic error d) loading error.

xii) Critically damped system means damping coefficient is

a) 1 b) > 1

c) < 1 d) 0.

GROUP – B

(Short Answer Type Questions)

Answer any *three* of the following. 3 × 5 = 15

2. Derive the transfer function of a first order system. 5

3. A step change of magnitude 4 is introduced into a system having transfer function

$$\frac{Y(s)}{X(s)} = \frac{1}{s^2 + 1 \cdot 6s + 4}$$

Determine overshoot, decay ratio and period of oscillation. 5

4. Write down the operating principle of resistance thermometer. 5

5. Calculate C/R for the following control loop : 5

6. What are cascade control & adaptive control ? 5

GROUP – C

(Long Answer Type Questions)

Answer any *three* of the following. 3 × 15 = 45

7. a) Explain the working principle of gas chromatography and polarography with suitable diagram.

   b) Explain Seebeck, Peltier and Thomson effects. Define a thermocouple and explain how it generates *e.m.f.* 7 + 8

8. a) Describe the behaviour of a typical feedback control system using different kinds of control action when it is subject to a permanent disturbance with sketch.

b) A Hg thermometer having a 1st order dynamics with a time constant of 60 sec is placed in a bath at 35°C. After the thermometer reaches a steady state it is suddenly placed in a bath at 40° C at t = 0 and left there for 60 sec after which it is immediately return to the bath at 35° C.

i) Calculate the thermometer reading at time t = 30 sec & 120 sec.

ii) Draw a sketch showing the variation of thermometer with time.

iii) What would be the reading at t = 6 sec if the thermometer had only been immersed in 40°C bath for less than 1 sec before being returned to 35° C bath. 5 + 10

9. a) Define proportional band.

b) Describe ON-OFF control.

c) Analyse the stability of the system having the following characteristic equation :

$$3s^4 + 10s^3 + 5s^2 + 5s + 2 = 0$$

d) State why PD control action referred as anticipatory control. 1 + 2 + 10 + 2

10. State the Bode stability criteria. Plot the Bode diagram for the system whose open loop transfer function is

$$G_s = \frac{1}{(s+1)(s+5)}$$ 15

11. Write short notes on any *three* of the following : 3 × 5

a) Static characteristics of instruments

b) PID controller

c) Static & Dynamic errors

d) Digital & Analog controller.