Name : .....

Roll No. : .....

Invigilator's Signature : .....

CS/B. Tech (CT)/SEM-7/CHE (CT) -701/2011-12

2011
INSTRUMENTATION AND PROCESS 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 the following : $10 \times 1 = 10$

   i) Bourdon gauge is a

   a) strain gauge b) screw gauge

   c) level gauge d) pressure gauge.

   ii) Typical input to a thermocouple is

   a) voltage b) current

   c) temperature d) pressure.

   iii) Ramp input is expressed as

   a) $x = x_0$

   b) $x = xt$

   c) $x = x_s \sin wt$

   d) none of these.

iv) Which of the following is a flow meter ?

a) LVDT b) Pyrommeter

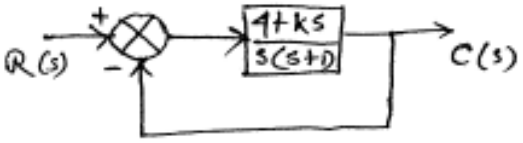
c) Rota-meter d) Potentiometer.

v) A transducer is

a) signal processing unit b) senor unit

c) display unit d) amplification unit.

vi) The system shown in the figure is critically damped for



a) $k = 0$

b) $k = -1$

c) $k = 3$.

vii) Improvement in accuracy in a PID controller is the effect of its

a) *P* mode

b) *I* mode

c) *D* mode.

viii) A system will be stable if

a) GM = $0 \cdot 5$ & PM = 30°

b) GM = 5 & PM = -30°

c) GM = ∞ & PM = 30°

ix) $\frac{1+s}{1+2s}$ is the transfer function of a

a) phase-lag system

b) phase lead system

c) none of these.

x) Transfer function of a system depends on

a) input

b) frequency

c) both frequency & input.

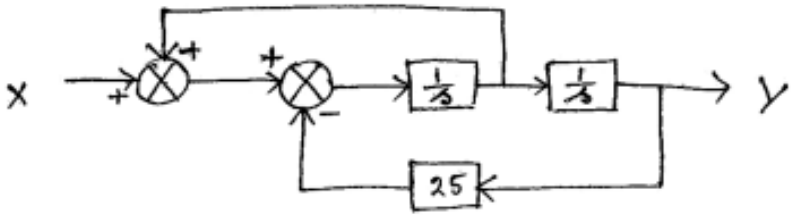
GROUP – B

(Short Answer Type Questions)

Write short notes on any *three* of the following.

$3 \times 5 = 15$

2. Derive the transfer function y/x for the control system shown in figure below.



3. Determine the condition for stability for a negative feedback system with forward path gain

$G(s) = \frac{k}{(\tau_1 s + 1)(\tau_2 s + 1)}$ and

feedback path gain

$H(s) = \frac{1}{s}$

4. a) Define closed loop and open loop systems with an example for each.

   b) What are the differences between the two ? 3 + 2

5. a) Why a Linear Variable Differential Transformer (LVDT) is used ?

   b) Briefly describe its working principle. 1 + 4

6. a) How is a thermistor prepared ?

   b) What is its general range of measurement ?

   c) Why is the sensitivity of a thermistor low ? 3 + 1 + 1

GROUP – C

(Long Answer Type Questions)

Answer any *three* of the following. $3 \times 15 = 45$

7. a) How can you measure vacuum with the help of a McLeod gauge ? Describe with a neat sketch.

   b) How can ultrasonic method be used for liquid level measurement ? 8 + 7

8. a) How does an electromagnetic flow-meter operate ?

   b) Describe the operating principle of a venturimeter. Compare its disadvantage/advantage with that of orificemeter. 6 + (6 + 3)

9. a) Derive the transfer function of an ordinary mercury-in-glass thermometer.

b) A thermometer having first-order dynamics with a time constant of 10 sec is allowed to come to equilibrium in the room air at $75^{\circ}F$. Then it is placed in the $400^{\circ}F$ oil bath for a length of time less than 1 sec, and quickly removed from the bath and re-exposed to the $75^{\circ}F$ ambient conditions. It may be estimated that the heat transfer coefficient to the thermometer in air is one-fifth of that in the oil bath. If 10 sec after the thermometer is removed from the bath it reads $98^{\circ}F$, estimate the length of time that the thermometer was in the bath.

7 + 8

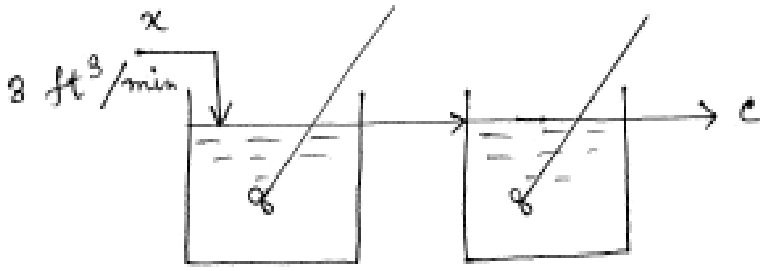
10. a) A mixing process is described as follows :

a stream with solute concentration C_i (lb/volm) is fed to a perfectly stirred tank at a constant flow rate of q (volm/min). The perfectly mixed product is withdrawn

from the tank at the same flow rate of q (volm/min) at the same concentration as the material in the tank, C_o

The total volume of solution in the tank is constant at V. If C_i is increased suddenly from 0 to 2 lb/gal, at time t = 0, find the trace of the tank concentration versus time.

b) In the two-tank mixing process shown in the following figure, x varies from 0 lb salt/ft^3 to 1 lb salt/ft^3 according to a step function. At what time does the salt concentration in tank 2 reach 0·6 lb salt/ft^3 ? The hold-up volume of each tank is 6 ft^3.



Tank1 Tank 2

11. a) Derive the transfer function of two non-interactive first order liquid level systems connected in series.

b) The liquid-level process shown in the figure below is operating at steady state when the following disturbance occurs : at time t = 0, 1 ft^3 water is added suddenly (unit impulse) to the tank; at t = 1 min, 2 ft^3 of water is added suddenly to the tank. Sketch the response of the level in the tank versus time and determine the level at t = 0·5 min, 1 min and 1·5 min.