

**BIRLA INSTITUTE OF TECHNOLOGY, MESRA, RANCHI  
(END SEMESTER EXAMINATION)**

**CLASS: BE  
BRANCH: CHEMICAL ENGG. / CEP&P**

**SEMESTER : VII  
SESSION : MO/18**

**SUBJECT: CL7001-PROCESS CONTROL AND INSTRUMENTATION**

**TIME: 03:00**

**FULL MARKS: 60**

**INSTRUCTIONS:**

1. The question paper contains 7 questions each of 12 marks and total 84 marks.
  2. Candidates may attempt any 5 questions maximum of 60 marks.
  3. The missing data, if any, may be assumed suitably.
  4. Before attempting the question paper, be sure that you have got the correct question paper.
  5. Tables/Data hand book/Graph paper etc. to be supplied to the candidates in the examination hall.
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- Q.1(a) Define absolute pressure and gauge pressure. [2]  
(b) Derive the expression for calculating theoretical flow rate in venturi meter. [4]  
(c) Derive the expression for calculating theoretical flow rate in orifice meter. [6]
- Q.2(a) Explain the concept of thermocouple. [2]  
(b) Find the transfer function for thermometer. [4]  
(c) A thermometer having a time constant of 1 min is initially at 50°C. It is immersed in a bath maintained at 100°C at t = 0. Determine the temperature reading at t = 1.2 min. [6]
- Q.3(a) A thermometer having first-order dynamics with a time constant of 1 min is placed in a temperature bath at 100°F. After the thermometer reaches steady state, it is suddenly placed in a bath at 110°F at t = 0 and left there for 1 min, after which it is immediately returned to the bath at 100°F. Draw a sketch showing the variation of the thermometer reading with time. [2]  
(b) Calculate thermometer reading at t = 0.5 min and at t = 2.0 min in the above question 3 (a) [4]  
(c) A thermometer having a time constant of 0.2 min is placed in a temperature bath, and after the thermometer comes to equilibrium with the bath, the temperature of the bath is increased linearly with time at a rate of 1°/min. Find the difference between the indicated temperature and the bath temperature. (a) 0.1 min after the change in temperature begins (b) 1.0 min after the change in temperature begins (c) what is the maximum deviation between indicated temperature and bath temperature, and when does it occur? (d) Plot the forcing function and response on the same graph. After a long enough time, by how many minutes does the response lag the input? [6]
- Q.4(a) Find the transfer function of liquid level system with constant flow outlet  $q_0$ . [2]  
(b) Find the transfer function of liquid level system with attaching resistance R in the outlet. [4]  
(c) Three tanks are connected in series, determine the transfer function  $H(s)/Q(s)$  for the liquid-level system. Resistances R1 and R2 are connected to the tank 1 and 2 respectively which is linear. The flow rate from tank 3 is maintained constant at  $q_0 = b$  by means of a pump; i.e., the flow rate from tank 3 is independent of head h. The tanks are noninteracting. [6]
- Q.5(a) Explain the Routh test theorem. [2]  
(b) Given the characteristic equation  $S^4 + 3S^3 + 5S^2 + 4S + 2 = 0$  determine the stability by the Routh criterion [4]  
(c) For the characteristic equation  $1 + \frac{K_c}{(S+1)(S/2+1)(S/3+1)} = 0$ , (a) find the value of  $K_c$  for which the system is stable. (b) For the value of  $K_c$  for which the system is on the threshold of instability, determine the roots of the characteristic equation [6]
- Q.6 Plot the root-locus diagram for open loop transfer function with writing all steps [12]
- $$G = \frac{K}{(S+1)(S+2)(S+3)}$$
- Q.7(a) Explain cascade control system. [4]  
(b) Explain feed forward control with example. [8]