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MANIPAL INSTITUTE OF TECHNOLOGY
MANIPAL
A Constituent Institution of Manipal University

FIFTH SEMESTER B.TECH. (INSTRUMENTATION AND CONTROL ENGG.) END SEMESTER EXAMINATIONS, DEC 2016/JAN 2017

SUBJECT: PROCESS INSTRUMENTATION AND CONTROL [ICE 3106]

Time: 3 Hours MAX. MARKS: 50

Instructions to Candidates:
- Answer **ALL** the questions.
- Missing data may be suitably assumed.

1A. In liquid-level system of Fig.Q.1A assume that the outflow rate Q m^3/sec through the outflow valve is related to the head H m by $Q = K\sqrt{H} = 0.01\sqrt{H}$. Assume that when the inflow rate Q is 0.015m^3/sec the head stays constant. For $t<0$ the system is at steady state (Q, = 0.015m^3/sec). At $t = 0$ the inflow valve is closed and so there is no inflow for $t> 0$. Find the time necessary to empty the tank to half the original head. The capacitance C of the tank is 2m^2. **5**

1B. Obtain the mathematical model and transfer of the system shown in Fig.Q.1B considering θ_o as output and h_i as input. **3**

1C. A heat flow through the medium follows the equation $q=K\theta^4$ where K is a constant. The resistance offered by the medium to heat flow is then given by: **2**

2A. For a servo problem, prove that integral controller eliminates offset for a first order system where $G_m=G_f=1$ and $G_p=K_p/\tau_{ps}+1$ and also show the effect of controller parameters on damping ratio with help of a graph. (assume set point as 1) **5**

2B. A liquid-level control system linearly converts a displacement of 2m to 3m into a 4 to 20mA control signal. A relay serves as the two-position controller to open or close an inlet valve. The relay closes at 12 mA and opens at 10 mA. Find the relation between displacement level and current, and the neutral zone in meters. **3**

2C. From the error graph shown in Fig.Q.2C, find out the region in which a derivative controller fails to act and justify it. **2**

3A. A liquid level system converts a 4-10m level into a 4 to 20mA current. Design a three mode controller that outputs 0-10V with a 60% PB, 0.04-min reset time and 0.06min derivative time. Fastest expected change time is 0.6min. **5**

3B. Draw the diagram of a Pneumatic P controller and derive the expression for the same. **3**

3C. Write the formula for 'Integral Square Error' time performance criteria and justify why it cannot be used for evaluating processes with small errors. **2**

4A. Explain the tuning method used for ultimate cycle method and write the expressions for PI and PID controller parameters. What is the advantage of damped oscillation method over this method? **5**

4B. What is dead time? Explain the technique for compensating dead time. **3**

4C. For the data given below prove that cascade system is more stable than general feedback system. **2**
Characteristic equation with only feedback loop: $1+G_{p1}G_{p2}G_{c1}$
Characteristic equation of cascade system: $1+G_{p2}G_{c2}+G_{p1}G_{p2}G_{c1}\ G_{c2}$
$G_{p1}=1/(s+1)^2$ and $G_{p2}=1/(s+1)$, $G_{c1}=K_{c1}$. $G_{c2}=K_{c2}$.

5A. Design an Internal Model controller for the first order process without delay time. **5**

5B. Name the control which can be used when disturbance as well as process output cannot be measured and explain with the help of an example. **3**

5C. Fig.Q.5C shows an example of a ratio control system. Explain the control action. **2**

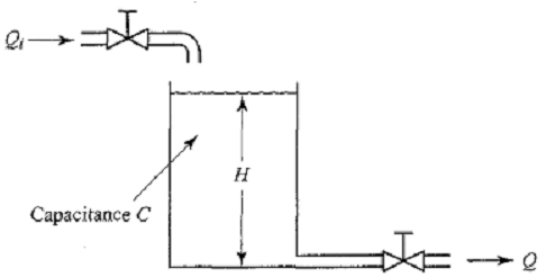

Fig.Q.1A

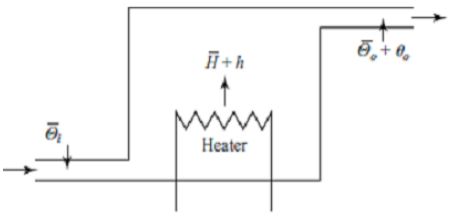

Fig.Q.1B

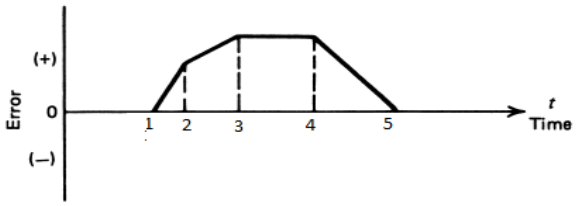

Fig.Q.2C

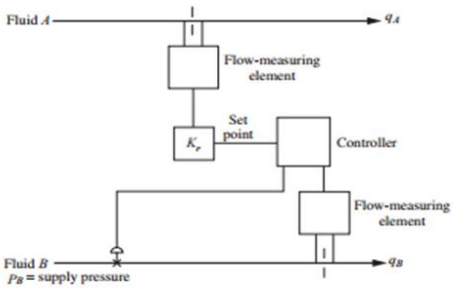

Fig.Q.5C

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