Ref No: EE/5/T/514/2019(old)

BACHELOR OF ENGINEERING (ELECTRICAL ENGINEERING) 5TH YR 1ST SEMESTER EXAMINATION, 2019 (OLD)

SUBJECT: - PROCESS INSTRUMENTATION AND CONTROL

Time: Three hours | Full Marks: 100

Answer any **FIVE** questions. 5×20

1. a) Draw the circuit diagram of a simple electronic analog PID controller with two OPAMP. 4
   b) Find the transfer function of the controller. 6
   c) Realize a digital PI controller using incremental form. 5
   d) What is meant by Anti Integral Wind-up action? Illustrate a scheme for incorporating Anti Integral Wind-up action for PID controller. 5

2. a) Realize P-I-D controller using flapper nozzle, bellows and restrictions. Find the transfer function, expression of proportional gain, derivative time and integral time in terms of system parameters. 7
   b) Describe a scheme for implementation of pneumatic P-controllers with direct acting relay. 3
   c) Why are relay valves employed in pneumatic proportional controllers? 5
   d) State the advantages and disadvantages of electronic process controller. 5

3. a) Prove that in a digital controller $m_n' = k_p\left(1+\frac{\tau}{T_i}\right)e_n - k_p e_{n-1} + m_{n-1}'$ where m_n is the controller output sequence and e_n is the error sequence. Show that input-output relation in block diagram form. 10
   b) Specify the techniques of anti-integral wind up in a digital PID controller. 7
   c) Also explain the hard switching scheme which is used for anti-integral scheme. 3

4. a) What is the function of final control element in a process control application? 3
   b) With a neat sketch describe the implementation of an electro-pneumatic actuator. 7
   c) Describe the working principle of rotary plug and butterfly valves with neat diagram. 5
   d) Compare the performance among quick opening, linear and equal percentage control valves. 5

5. a) Derive the mathematical model interacting two tank system with linear resistance element. 8
   b) Derive the transfer function $\frac{H(S)}{Q(S)}$ for the liquid level system shown in fig. [H and Qi are the deviation variables in 'h' and 'q_i' respectively. 8

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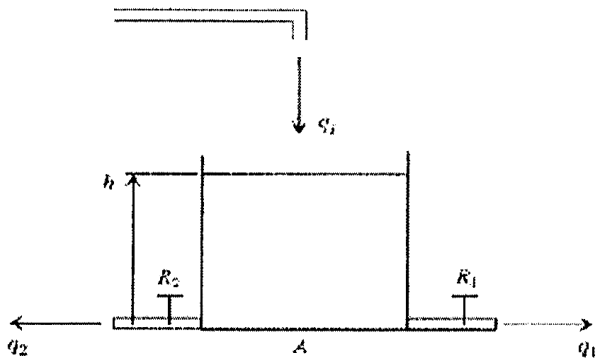
Assume $A=0.75m^2$, $R_1=2$, $R_2=3$.



c) What is integral windup? 4

6. a) Discuss the advantage of applying cascade control in jacketed CSTR. 8

b) Consider a closed loop system in which the process comprises of two first order systems connected in series with time constants 1min and ½ min, respectively. Measuring element is also a first order system with time constant of ½ min. Controller is of proportional mode with gain Kp. 8

(i) Draw the process control loop.

(ii) Using direct substitution method, comment on the stability with the limiting range of Kp.

7. c) Write the difference between servo and regulatory system. 4

a) Why feedforward control is preferred along with feedback control? Explain feedforward control strategy for a typical process. 16

b) Discuss degree of freedom analysis in mathematical modeling. 4

8. a) Write the difference between servo and regulatory system. 4

b) Discuss Multivariable control structure (MVC) with 1-1/2-2 controller pairing and 1-2/2-1 controller pairing. 16