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Roll No.

M.Tech (C&I)

FIRST SEMESTER

SUPPLEMENTARY EXAMINATION

(Feb.-2019)

EE-513 PROCESS INSTRUMENTATION & CONTROL

Time: 3:00 Hours

Maximum Marks : 100

Note : Question No. **ONE** is compulsory.
Answer any **FOUR** questions from the remaining.
Assume suitable missing data, if any.

1 Answer in brief.

[a] The model equation of a liquid level system is given by

$$\frac{dV}{dt} = q_1 - q_2$$

Where V is the volume of liquid in the tank and q1 and q2 are inflow and out flow rate respectively. Draw a feed forward control strategy PI diagram as well as block diagram to control level in the tank.

[b] Write transfer function of a first order process with delay. How do you determine the time constant and gain?

[c] In developing dynamic model of the processes either integral balance or instantaneous balance methods are adopted. Name the processes in which these methods are used to develop the process model.

[d] In gas surge drum, if v is the volume of the drum n = total amount of gas moles contained in the drum, qi and q are the inlet and outlet molar flow rate then write the relationship for the pressure in the drum, p and molar flow rates. Is it an integrating process?

[e] In a Jacketed Stirred Tank heater, identify the input and output variables.

[f] Differentiate between Indirect and direct ratio control methods?

[g] What are three common type of energy in thermal process? Write equation for total energy.

[h] Draw a schematic diagram of a stirred-tank heater (STH) and find the process gain kp and time constant tp, Assume the STH has following parameters. Volume Vs= 50 liters; Flow rate Fs= 10 liters/min. cp=1 kcal/liter °C.

[i] What is split range control in processes?

[j] State and describe control algorithm of an on-off controller for level control in a tank. Assume h the measured level, hsp desired height and Δh is the width of the band over which the level is to be maintained. Draw the necessary PI diagram also.

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2 The transfer function of a process and measurement element is given by.

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$$g(s) = \frac{e^{-0.4s}}{(2s+1)(2s+1)}$$

- (i) Specify the gain of the proportional controller to be used in this control.
(ii) Sketch Bode plot of the g(s).

3 Describe with help of neat Process instrumentation and block diagrams the feedback and feed forward control strategy for temperature control, where a fired furnace is used to heat a process stream. The outlet temperature is controlled by manipulating the valve position of the fuel gas control valve and feed forward controller measure the disturbance in the process fluid flow rate and adjust the manipulated input.

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4[a] The first order process is defined as

$$G(s) = \frac{k}{Ts + 1}$$

Determine the offset due to step set point change in process with P controller having gain K_c .

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[b] Draw a schematic and also a block diagram for a pneumatic PI controller and explain its operation to control the pressure. Derive transfer function of the controller $p_c(s)/e(s)$. State the condition of valve resistance and stiffness of the bellows under which PI controller acts as an on-off controller.

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5[a] Two interacting liquid level control (first order process) are operating in series with equal time constant. Derive the overall transfer function q_o/q_i of the process. Determine and sketch the time response of level change for unit step change in inlet flow rate.

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[b] A conveyor belt is run by switching on/off a motor. An optical detector is placed to detect the bottle on the conveyer. Upon detecting a bottle on the conveyor belt for 1.5 sec., the conveyor belt is stopped for 2 sec. to fill the bottle with juice. Use momentarily pressed start button and NC stop button. A light should be on when the system starts. When 100 bottles of juice are filled, the conveyor belt stops moving and light also goes off. Draw the PLC ladder diagram to implement this control scheme

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6 What is the ratio control? Which type of processes use ratio control? Draw a block diagram of indirect and direct approach for implementing ratio control and determine the process gain.

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7 What is the fundamental characteristic structure of cascade control? Draw a neat block diagram for cascade control scheme in a fired furnace and derive the closed-loop transfer function relating the primary set point to the primary process output for a cascade-control system. Also discuss the purpose of the secondary loop in a cascade control structure. Discuss the tuning procedure for a cascade control system.

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