Ref. No. : Ex/EE/T/324/2017

B.E. ELECTRICAL ENGINEERING THIRD YEAR SECOND SEMESTER - 2017

PROCESS INSTRUMENTATION & CONTROL

Time : 3 hours | Full Marks : 100

(50 marks for each part)

Use Separate Answer scripts for each part.

Part –I

Answer any THREE questions.

Two marks reserved for neatness. ***Answer all parts of a question in the sequential order.***

1. a) Explain the importance and necessity of automatic process control. [5]

b) Explain the various process variables involved in any automatic process control systems with the help of a schematic diagram of any common industrial process control system. [3]

c) Briefly explain the general approach of process modelling. [3]

d) A heat transfer process has the following specifications:

heat transfer: H_t
overall heat transfer coefficient: H_0
tank mass: m
specific heat of the material: C
temperature difference between the heat donor and heat receiver: T_d

Derive the mathematical model of the process employing the heat balance equation.

[5]

2. a) Explain, with suitable example, the "direct acting" and "reverse acting" modes in process control. [4]

b) Explain the following:

i) Process reaction curve.
ii) Dead time.
iii) Proportional band.

[2x3=6]

c) A proportional controller generates a control signal of 4 mA when the error signal is -16 mA and the control signal is 20 mA when the error signal is 16 mA. The control valve is normally a closed-type valve. It is fully open when the input current to it is 20mA. Determine the proportional gain, proportional band, and the bias signal of the controller.

[6]

[Turn over

3. a) Explain the operation of the two-position and multi-position process control systems with the help of suitable example. [5]

b) Explain the operation of the Proportional, Proportional+Integral, and Proportional+Integral+Derivative control in any closed-loop process control system. [6]

c) "*A PID Controller is often called as Gain-Reset-Preact Controller*" – elucidate. [5]

4. a) Explain the various effects due to the operation of Proportional, Proportional+Integral, and Proportional+Integral+Derivative control actions on the closed-loop response of first order and second order processes. [8]

b) Explain, stating the assumptions, Zieglar-Nichols method of tuning of a PID controller. [6]

c) What is the remedy when there is difficulty in finding the Critical gain? [2]

5. Write short note on: [4x4=16]

a) Frequency domain method of process identification.

b) Ratio control

c) Cascade control

d) Feedforward control

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B. ELECTRICAL ENGINEERING 3RD YEAR 2ND SEMESTER EXAMINATION, 2017

SUBJECT: - PROCESS INSTRUMENTATION & CONTROL

Time:Three hours

Full Marks 100
(50 marks for each part)

Use a separate Answer-Script for each part

No. of Questions	PART II	Marks
	Answer any three questions. Q.1 carries 18 marks.	
1.	Justify or correct ***any four*** of the following statements with suitable reasons/derivations, in brief.	$4\times4\frac{1}{2}=18$
(a)	Compared to electronic process controllers, pneumatic process controllers suffer less from the problem of transmission lag.	
(b)	In using direct-acting relay valves with pneumatic baffle-nozzle amplifiers, bleed-type relays are preferred over non-bleed type relays.	
(c)	Solenoid type electric actuators are used for ON/OFF operation only.	
(d)	Lifting gate control valves are used to control flow of fluids containing solid matters.	
(e)	Multiplexed serial data transmission systems are adapted for multi-loop control to reduce sensor errors and interface inaccuracies.	
2. (a)	Describe the circuit implementation of an electronic PID controller employing two op-amps and derive its transfer function. Under what special considerations can this circuit be further implemented in a simpler form using only one op-amp?	07+02
(b)	In pneumatic baffle-nozzle amplifier how are provisions made for providing mechanical set point and accepting pneumatic measured variable?	04

[Turn over

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B. ELECTRICAL ENGINEERING 3RD YEAR 2ND SEMESTER EXAMINATION, 2017

SUBJECT: - PROCESS INSTRUMENTATION & CONTROL

Full Marks 100

Time:Three hours (50 marks for each part)

Use a separate Answer-Script for each part

No. of Questions	PART II	Marks
2. (c)	In developing transfer functions for pneumatic PD controllers, why do we make the assumption of $R_D >> R$, where each symbol has its usual meaning?	03
3. (a)	Describe in detail the realization of a digital PID controller employing backward difference algorithm, trapezoidal rule for integration, and with anti-derivative kick feature.	07
(b)	"In developing anti-integral windup schemes for PI/PID controllers, it is always better to develop a soft switching scheme than a hard switching scheme". – Justify or rectify the statement.	04
(c)	Under what circumstances incremental forms of realization of process controllers are preferred?	03
(d)	What are the preferred choices of electrical and pneumatic signal transmission standards in a process control loop?	02
4. (a)	Prove, with detail derivation, that the incorporation of positioners with spring-diaphragm type actuators helps in improving linearity and reducing hysteresis.	07
(b)	What is Smith's principle for control of time-delay systems? What is the importance of model estimates of the delay free process and the amount of time delay in this regard?	04+02
(c)	Why is Smith's controller for control of time-delay systems also very often called Smith's predictor?	03

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B. ELECTRICAL ENGINEERING 3RD YEAR 2ND SEMESTER EXAMINATION, 2017

SUBJECT: - PROCESS INSTRUMENTATION & CONTROL

Full Marks 100

Time:Three hours (50 marks for each part)

Use a separate Answer-Script for each part

No. of Questions	PART II	Marks
5.	Write short notes on ***any two*** of the following:	8×2=16
(i)	Rotary plug type control valves, ball valves and butterfly valves.	
(ii)	RS-232C based Data Transmission Systems.	
(iii)	Process instrumentation diagrams for liquid level control and flow control systems.	