KUMARAGURU college of technology
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B.TECH. DEGREE EXAMINATIONS: MAY 2017

(Regulation 2014)

Sixth Semester

BIOTECHNOLOGY

U14BTT601: Bioprocess Control and Automation

COURSE OUTCOMES

CO1: The students would understand basic principles of process control system.

CO2: The students would understand controllers and control elements in process control.

CO3: The students would design control system for bioreactors.

CO4: The students would apply knowledge on control system in bioprocess industries.

CO5: The students would apply knowledge on control system in bioreactors.

Time: Three Hours **Maximum Marks: 100**

Answer all the Questions

PART A (10 x 1 = 10 Marks)

1. Match the List I (Process) with List II their (System). CO1 [K_3]

PROCESS	SYSTEM
A. Thermometer	i. Behaving like 2nd order
B. Control valve	ii. Inherently 2nd order
C. Manometer	iii. 1st order and/or 2nd order
D. Fermenters in series	iv. 1st order

a) A-iv, B-iii, C-ii, D-i b) A-iii, B-ii, C-iv, D-i

c) A-iii, B-iv, C-ii, D-i d) A-iv, B-i, C-iii, D-ii

2. 63.2% of the final response value of the 1st order system is equal to one unit of CO1 [K_2]

a) Time constant b) Dead time

c) Damping coefficient d) Integral time

3. Order the following components in the correct sequence of the control system as they appear in the control loop. CO2 [K_3]

   A. Process
   B. Control valve
   C. Controller
   D. Comparator
   E. Measuring device

	a) D-C-B-A-E	b) D-B-C-E-A			
	c) A-B-D-C-E	d) C-E-A-D-B			
4.	Select the controllers which can be suitable for temperature as well as composition control mechanism. A. P controller B. PD controller C. PI controller D. PID controller			CO2	[K_3]
	a) A,B	b) A,D			
	c) C,D	d) B,C			
5.	Frequency analysis is critically used for determination of			CO3	[K_2]
	a) Stability analysis	b) Optimal controller setting			
	c) Phase margin & gain margin	d) All of the above			
6.	Calculate the amplitude ratio for the transfer function $G(S) = \frac{2}{0.5s + 1}$, if ω = 0.1			CO3	[K_5]
	a) 0.998	b) 0.499			
	c) 1.2	d) 0.613			
7.	Assertion (A): A dynamic system is considered to be stable if for every bounded input it produces bounded output, regardless of its initial state. Reason (R): When the amplitude ration of an open loop system at its cross over frequency exceeds unity, the system is deemed to be unstable.			CO4	[K_2]
	a) Both (A) and (R) are true and (R) is the correct explanation of (A)	b) Both (A) and (R) are false but (R) is not a correct explanation of (A)			
	c) (A) is false but (R) is true	d) (A) is true but (R) is false			
8.	From the following, select the control strategy used to maintain the medium composition in a submerged fermenter.			CO4	[K_2]
	a) Ratio control	b) Feedback control			
	c) Cascade control	d) Feed-forward control			
9.	Select the device which is excluded in the PID diagram			CO5	[K_2]
	a) Piping	b) Control device			
	c) Instrumentation	d) Painting			

10. Distributed control system uses the following parameters for building up models and subsequently the controller design. CO5 [K_2]

a) Time & temperature b) Time & pressure

c) Time & composition d) Time & space

PART B (10 x 2 = 20 Marks)

(Answer not more than 40 words)

11. Define time constant and damping parameter. CO1 [K_2]
12. What is time delay and write its transfer function? CO1 [K_2]
13. Compare the offsets of conventional controllers. CO2 [K_4]
14. Bring your conclusions on stability in terms of roots of the transfer function. CO2 [K_4]
15. Find the amplitude ratio and phase angle for the transfer function $G(S) = \frac{1}{s+2}$ CO3 [K_4]
16. Compare the terms corner frequency and cross-over frequency. CO3 [K_2]
17. Differentiate the feedback and feed-forward control strategies. CO4 [K_3]
18. List the types of control valves based on valve heads and performance. CO4 [K_3]
19. Recite the principle of programme logic controllers. CO5 [K_2]
20. Draw and indicate the control accessories in a bioreactor. CO5 [K_2]

Answer any FIVE Questions

PART C (5 x 14 = 70 Marks)

(Answer not more than 300 words)

Q.No. 21 is Compulsory

21. a) Derive the transfer function of a mercury filled-in thermometer which is immersed in a hot fluid. (7) CO1 [K_3]

    b) Consider a thermocouple immersed in an autoclave and its initial steady state temperature is 40^{o}C. Autoclave is charged with medium and its temperature is linearly raised in the rate of 4 ^{o}C/s. Suppose the time constant of thermocouple is 2 seconds, Draw the performance curve for the duration 0 to 30 seconds. (7) CO1 [K_5]

22. a) A pipe line transfers insulin from mega scale submerged fermenter. A manometer of length "l" and diameter "d" is used for pressure drop measurement. Derive its transfer function. (7) CO1 [K_4]

    b) Find the characteristic parameters of the following under damped second order system: $G(S) = \frac{16}{1.5s^2 + 2.4s + 6}$ (7) CO1 [K_5]

23.	a) Explain the feedback control loop implementation for a bioreactor for which temperature to be maintained in the desired condition.	(7)	CO2	[K_3]
	b) Derive the transfer functions of Proportional, Proportional-Derivative, Proportional-integral and Proportional-Derivative-Integral controllers.	(7)	CO2	[K_3]
24.	Draw the asymptotic bode plot of the open loop transfer function $G(S) = \frac{K_c\,(10s+1)}{(0.1s+1)(s+1)}$		CO3	[K_3]
25.	a) Explain the phase margin and gain margin.	(5)	CO4	[K_2]
	b) Elucidate the cascade methodology for a bioreactor temperature control.	(9)	CO4	[K_2]
26.	a) Write short notes on: Hysteresis, dead-band and inherent and installed characteristics of a control valve.	(6)	CO4	[K_2]
	b) Obtain the optimum control settings of a control loop having open-loop transfer function: $G(S) = \frac{K_c}{(s+1)^4}$. Use Zigler-Nichols optimum control settings.	(8)	CO4	[K_4]
27.	Describe the online estimation and monitoring of pH, temperature, dissolved oxygen and liquid level in bioreactors.		CO5	[K_3]

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