MANIPAL INSTITUTE OF TECHNOLOGY
MANIPAL
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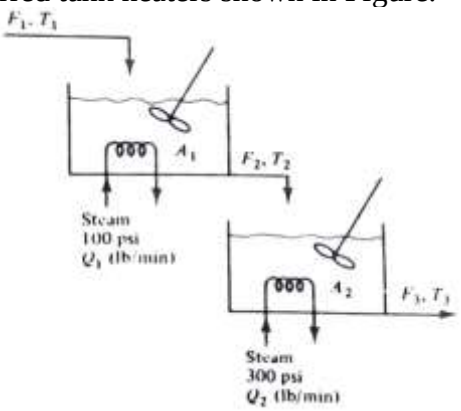
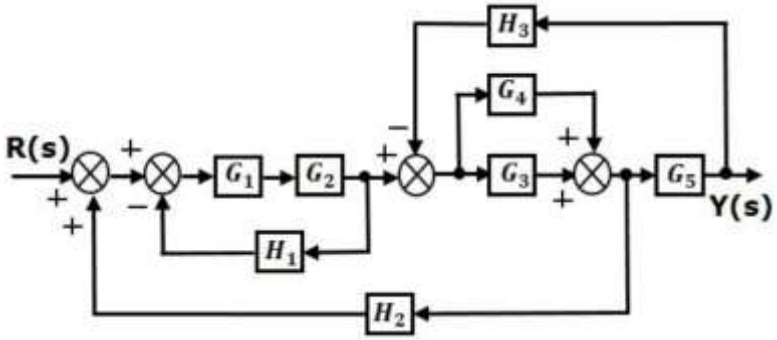
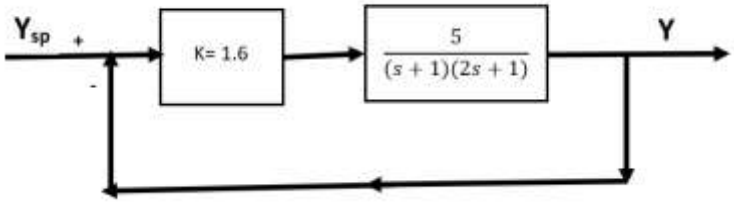
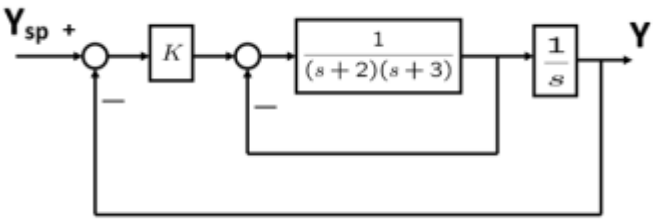
VI SEMESTER B.TECH (BIOTECHNOLOGY)
END SEMESTER EXAMINATION, 17 May 2022
SUBJECT: Bioprocess Control & Instrumentation (BIO 3252)
REVISED CREDIT SYSTEM
ANSWER ALL QUESTIONS

TIME: 3 HOURS **MAX. MARKS: 50**

Q. NO		MARKS	CO	BTL
1A	What are the main control objectives of Bioprocess plant.	**2**	**1**	**1**
1B	What are the external disturbances in a stirred tank heater and how will you design (all possible ways) a control system to suppress the external disturbances.	**5**	1	**4**
1C	Briefly explain the response of a stable and unstable process with neat diagram.	**3**	1	**2**
2A	Label important common measurements and controls in a bioreactor.	**2**	2	**1**
2B	What are the basic requirements of a sensor or transducer and briefly explain them	**4**	2	**1**
2C	Consider the two stirred tank heaters shown in Figure.  The flow rates of the effluent streams are assumed to be proportional to the liquid static pressure that causes the flow of the liquid. The cross-sectional areas of the two tanks are A_1 and A_2 (ft_3) and the flow rates are volumetric. No vapor is produced either in the first or the second tank. $A_{t,1}$ and $A_{t,2}$ are the heat exchange areas for the two steam coils.	**4**	2	**5**
3A	Using partial fraction expansion, find x(t) for (a) $X(s) = \frac{S(S+1)}{(S+2)(S+3)(S+4)}$ (b) $X(s) = \frac{(S+1)}{(S+2)(S+3)(S^2+4)}$	**5**	3	**6**
3B	A heated process is used to heat the liquid in the tank with first order dynamics, that is, the transfer function relating changes in temperature T to changes in the heater input power level P is	**3**	3	**6**

	$$\frac{T(s)}{P(s)} = \frac{K}{\tau s + 1}$$ Where K has units [^{o}C/Kw] and τ has units (minutes). The process is at steady state when an engineer changes the power input stepwise from 1 to 1.5 Kw, the following have been observed: (a) The process temperature initially is 80 ^{o}C. (b) Four minutes after changing the power input, the temperature is 230 ^{o}C. (c) Thirty minutes later (steady state) the temperature is 280 ^{o}C. Determine the values of K and τ in the process transfer function			
3C	What are the 3 categories, where the second order or higher dynamics can arise from several physical situations.	**2**	3	**1**
4A	Briefly explain the direct acting and reverse acting control valve function.	**2**	2	**3**
4B	Consider the block diagram shown in the following figure. simplify (reduce) this block diagram using the block diagram reduction rules. 	**4**	4	**5**
4C	The setpoint of the control system in figure given a step change of 0.1 unit. Determine  (a) offset, (b) overshoot, (c) decay ratio and (d) period of oscillation	**4**	4	**6**
5A	Determine the range of K that stabilizes the below closed loop system 	**4**	4	**5**

5B	Consider a process with the transfer function: $$G_p(s) = \frac{1}{(s^4 + 10s^3 + 36s^2 + 56s + 32)}$$ If a PI Controller is used to control this process, determine the value of the integral time τ_I and K_c using the Ziegler-Nichols closed loop tuning method.	**3**	5	**6**
5c	Briefly explain the trouble shooting of common control loops.	**3**	5	**2**
CO: Course Outcome; BLOOM TAXONOMY LEVEL: 1-Remember, 2-Understand, 3-Apply, 4-Analyze, 5-Evaluate, 6-Create				