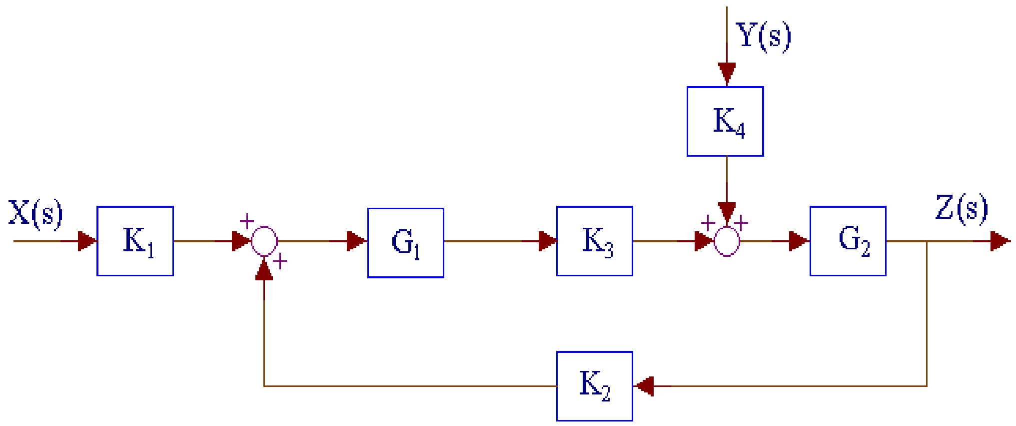
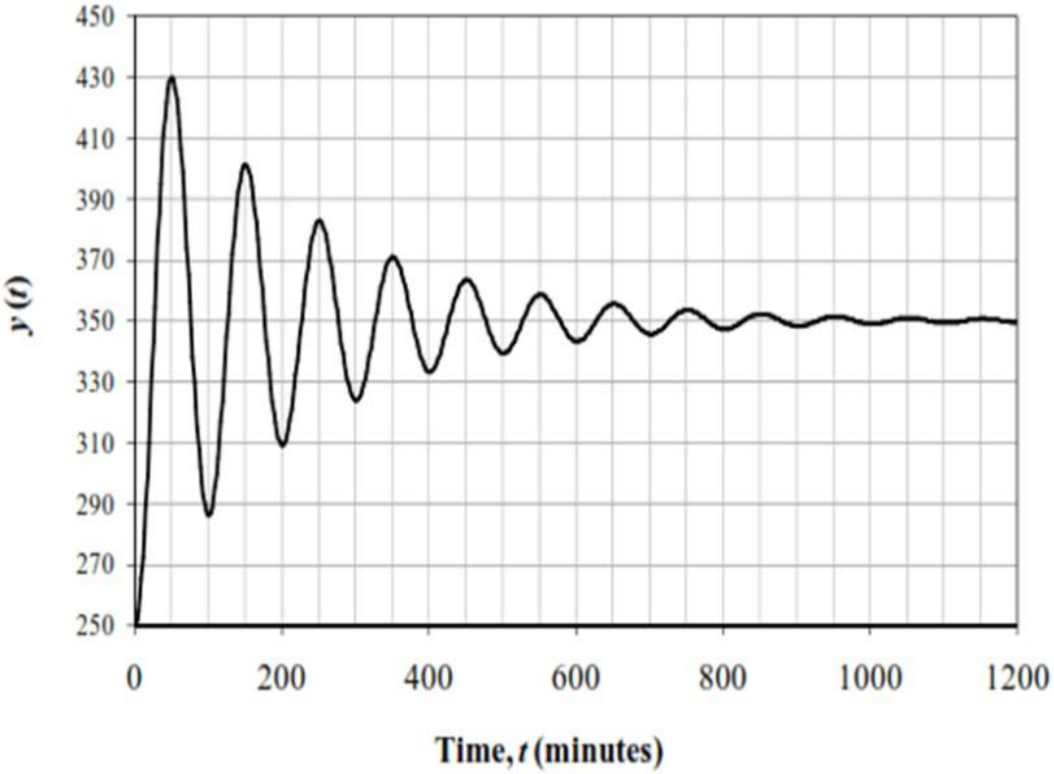
Name: **Enrolment No:**	UPES

UNIVERSITY OF PETROLEUM AND ENERGY STUDIES
End Semester Examination, May 2018

Course: B. Tech APE GAS **Semester: VI**
Subject: Process Dynamics Instrumentation and Control
Time: 03 hrs. **Max. Marks: 100**
Instructions: Assume the appropriate value of missing data if any.

S. No.		Marks	CO
	SECTION A (4×5=20 M) **All the questions are compulsory**		
Q 1	Explain the working of the following instruments with the help of neat sketch (i) Radiation pyrometer (ii) Bourdon tube pressure gauge	**4**	**CO1**
Q 2	Draw the block diagram of a control system illustrating a cascade control loop and a feed forward control loop.	**4**	**CO2**
Q 3	Discuss the concept of simple performance criteria and time integral performance criteria of controller setting.	**4**	**CO4**
Q 4	Explain the terms 'amplitude ratio', 'proportional band', 'transducer', and 'offset'.	**4**	**CO3**
Q 5	Define stability of a control system. How do you determine the stability from the characteristic equation?	**4**	**CO3**
	SECTION B (10×4= 40 M) **Answer all the questions. Q 8 has an internal choice**		
Q 6	Draw the root locus diagram for the open loop transfer function (use graph sheets to draw the root locus). $G(s)=\dfrac{K}{(s+1)(s+2)(s+3)}$. Find the value of K for which the closed loop response is stable.	**10**	**CO3**
Q 7	The open loop transfer function of a process with a proportional controller (gain K_C) is, $G_{OL}(s)=K_c\dfrac{\exp(-2s)}{s}$. Based on the Bode criterion for closed-loop stability, find the ultimate gain of the controller and the ultimate period of oscillation.	**10**	**CO3**
Q 8	A proportional controller is used for the control of a first order process. If the dynamics of all other units in the control loop are negligible and their steady state gains are all equal to unity, show that **(a)** the response of controlled process is faster than that of the uncontrolled process **(b)** the offset, for change in set point, decreases as the parameter of the controller is increased.	**10**	**CO2**

	OR Consider the positive feedback loop with load interaction; find the servo response and regulatory response for unit step disturbance in set point and the load respectively. Find the offset in the output due to step change of magnitude 4 in the set point, using the following data, $G_1 = 0.25/(s+2)$, $G_2 = 8(s-1)$.  	**10**	**CO5**
Q 9	A PI controller with integral time constant of 0.1 min is to be designed to control a process with transfer function, $G_p(s) = \dfrac{10}{s^2 + 2s + 100}$. Assume the transfer functions of the measuring element and the final control element are both unity. Find the gain of the controller that will constitute the critical condition for stability of the PI feedback control system.	**10**	**CO2**
	SECTION-C (20×2= 40 M) **Answer any two questions**		
Q 10	Consider the following second order plus dead time process. $$G_P = \frac{3e^{-2s}}{s^2 + 0.2s + 1}.$$ Transfer function of all other elements in the control loop is unity. Draw a Bode plo frequency range $0.01 \le \omega \le 10$ qualitatively (make a table for AR and ϕ Vs ω and draw the Bode plot qualitatively on the plane) paper) Design a PID controller using Ziegler-Nichols tuning technique.[Hint: In order to calculate the cross over frequency, use hit and trial method. The cross over frequency is one of the following three, 0.8734, 0.9178, 0.9635 and you may use hit and trial method for the same]	**20**	**CO4**

Q 11	For a unit step input, the response of a second order system is given as, $y(t)=K_P\left(1-\frac{1}{\sqrt{1-\zeta^2}}e^{-\zeta t/\tau}\sin(\frac{\sqrt{1-\zeta^2}}{\tau}t+\phi)\right)$. Where, K_p is the steady state gain, ζ is the damping coefficient, τ is the natural period of oscillation and ϕ is the phase lag. For a unit step input, the response of the system from an initial steady state condition at t = 0 is shown in the figure below. Find the decay ratio, rise time, period of oscillation and the overall transfer function of the process in terms of process gain K_p. 	**20**	**CO5**
Q 12	A jacketed vessel is used to cool a process stream as shown in the figure. The volume of liquid in the tank V and the volume of coolant in the jacket V_j always remain constant. Volumetric flow rate q is constant but q_j varies with time. Heat loss from the jacketed vessel is negligible .	**20**	**CO1**

Both tank contents and jacket contents are well mixed and have significant thermal capacities. Thermal capacities of tank wall and jacket wall are negligible. The overall heat transfer coefficient for transfer between tank liquid and coolant varies with coolant flow rate, $U = K q_j^{0.8}$, Where K is constant. Derive a transfer function model for this system. (State any additional assumptions that you make.)