Reg. No.										

Manipal Institute of Technology, Manipal

(A Constituent Institute of Manipal University)

FIRST SEMESTER M.TECH (Control Systems)

END SEMESTER EXAMINATIONS, NOV/DEC 2015

SUBJECT: PROCESS DYNAMICS AND CONTROL [ICE 521]

Time: 3 Hours MAX. MARKS: 50

Instructions to Candidates:

- Answer **ANY FIVE FULL** questions.
- Missing data may be suitably assumed.

1A.	Draw the schematic of a typical single loop temperature control system with air to open valve and also draw an alternate structure with air to close valve. Discuss the merits and demerits of both the loops.	**5**
1B.	Develop the mathematical model of a pneumatic system as given in figure 1(a). Also discuss about the pneumatic capacitance and resistance.	**5**
2A.	Draw the schematic of a continuous reactor system and discuss the operation of the following control loops: a). Level b). Flow c). Temperature d). Pressure e). Cascade Control (Temp-Temp) f). Ratio Control	**10**
3A.	The temperature of water in a tank is controlled by a two-position controller. When the heater is *off* the temperature drops at 4 ^{0}K per minute. When the heater is *on* the temperature rises at 7 ^{0}K per minute. The setpoint is 330 ^{0}K and the neutral zone is ±4% of the setpoint. There is a 0.5-min lag at both the *on* and *off* switch points. Find the period of oscillation and plot the water temperature versus time.	**4**
3B.	Explain the proportional control algorithm and the effect of controller output with increase in gain. Also discuss about offset and derive the equation for offset for servo and regulatory control for the system given in figure 3(b).	**6**
4A.	An integral controller is used for speed control with a setpoint of 12 rpm within a range of 10 to 15 rpm. The controller output is 20% initially. The constant $K_I = -0.15\%$ controller output per second per percentage error. If the speed jumps to 13.5 rpm, calculate the controller output after 5s for a constant e_p.	**3**
4B.	Given the error of Figure 4(b), plot a graph of a proportional-integral controller output as a function of time. $K_P = 10$, $K_I = 2.0\ s^{-1}$, and $P_I(0) = 10\%$.	**4**
4C.	Derivative control action with a gain of $K_D = 0.04\%$ /(%/min) is needed to control flow through a pipe. The flow surges with a minimum period of 2.2 s. The input signal has a range of 0.4 to 2.0 V, and the output varies from 0.0 to 5.0 V. Develop the op amp derivative action circuit.	**3**

5A. What do you understand from time-integral performance criteria? Explain the types and compare the performance of each type with a graph. **3**

5B. Design a split range control for a process where the pH value of process liquid is brought closer to neutral by the addition of either acid or caustic reagent liquids and explain its working. (Use air to open and air to close valve for acid and base inlet streams based on requirement. Make necessary assumptions.) **4**

5C. Explain the selective control strategy with an example. **3**

6A. Design an IMC controller for a process as given below: **4**

$$G = 0.8\frac{e^{-0.2s}}{3s+1}$$

6B. Explain the working of a hydraulic actuator with directional control valve with necessary sketch. **4**

6C. A control valve regulates the liquid flow of a tank. The water level is controlled in the tank at a level of 25 feet by regulating the outflow. The measured inflow varies from 0 to 120 gallons per minute. Calculate Cv for the valve. (1 foot of water develops a pressure of 0.433 psi). **2**

Figures:

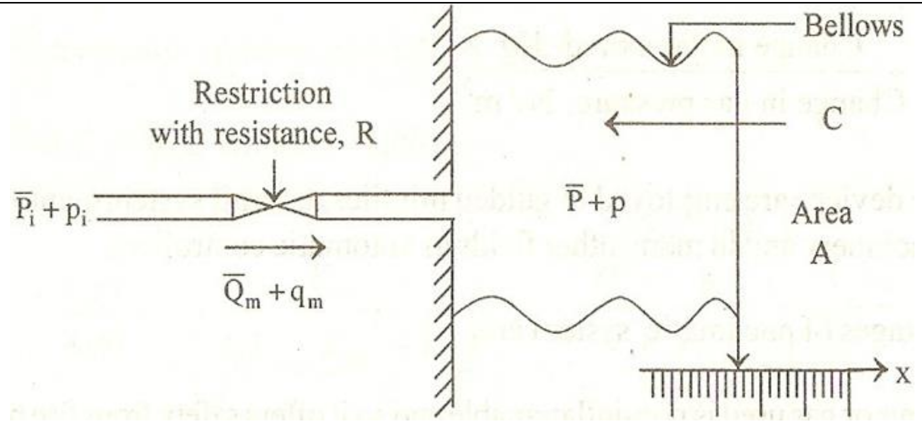

Figure 1(b)

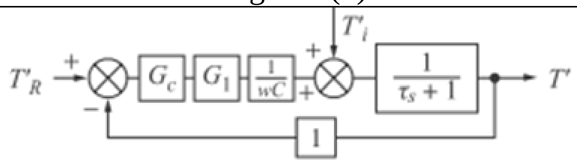

Figure 3(b)

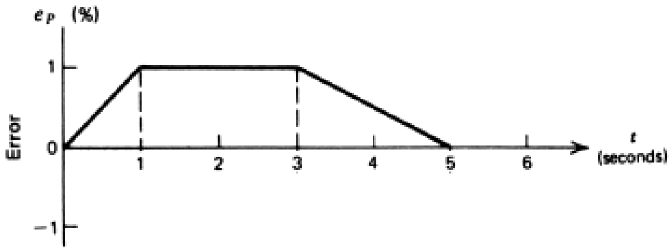

Figure 4(b)