Reg. No.										

MANIPAL INSTITUTE OF TECHNOLOGY

MANIPAL

A Constituent Institution of Manipal University

SEVENTH SEMESTER B.TECH (INSTRUMENTATION & CONTROL ENGG.)

END SEMESTER EXAMINATIONS, NOV/DEC 2016

SUBJECT: PROCESS INSTRUMENTATION AND CONTROL [ICE 401]

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 pressure control system with air to close valve and also draw an alternate structure with air to open valve. Discuss the merits and demerits of both the loops. **4**

1B. Consider an interacting two tank liquid level system and develop the mathematical model for the same. **4**

1C. Define the following: a). Controlled variable b). Manipulated variable **2**

2A. For the figure given in Q2A, discuss the line designation, line symbols and equipment designation. **3**

2B. Identify and explain ratio and cascade control loops implemented in the P & I diagram given in figure Q2B. **4**

2C. The temperature of water in a tank is controlled by a two-position controller. When the heater is *off* the temperature drops at 3 K per minute. When the heater is *on* the temperature rises at 6 K per minute. The setpoint is 340 K and the neutral zone is ±6% of the setpoint. There is a 1-min lag at both the *on* and *off* switch points. Find the period of oscillation and plot the water temperature versus time. **3**

3A. Consider the proportional-mode level-control system of Figure Q3A. Valve A is linear, with a flow scale factor of $10 m^3/hr$ per percent controller output. The controller output is nominally 50% with a constant of 10% per %. A load change occurs when flow through valve B changes from $500 m^3/hr$ to $600 m^3/hr$. Calculate the new controller output and offset error. **3**

3B. Design a three position controller using opamps. Analyze the circuit and derive the expression for output Vo. **4**

3C. A 5m diameter cylindrical tank is emptied by a constant outflow of $1.0\ m^3/min$. A two position controller is used to open and close a fill valve with an open flow of $3.0\ m^3/min$. For level control, the neutral zone is 1.5 m and the setpoint is 12 m. (a) Calculate the cycling period (b) Plot the level vs time. **3**

4A. A PI controller is used to control flow within a range of 20 to 100 gal/min. The set point is 60 gal/min, and the controller output drives a valve with a 3- to 15-psi signal. The controller settings are direct action, KP = -0.9, KI = 0.4 min^{-1}. Plot the pneumatic pressure for the flow of Fig Q4A.Assume an initial pressure output of 10.8 psi. **4**

4B. A pneumatic proportional controller is designed such that x1 is 5cms and x2 is 2.5cms. The setpoint is 50 kPa and the effective areas of the bellows are 7 cm^2. The nozzle / flapper system has a pressure/displacement characteristic as shown in FigQ4B. With no error, the output pressure is 60 kPa. **3**

- What nozzle/flapper gap is required to support an output of 50 kPa?
- With no error, how much force in Newtons and pounds does the input bellows exert on the flapper?
- Suppose the input increases to 60 kPa. What force is now required by the feedback bellows? What output pressure?
- What new gap is required? How much did the flapper move?

4C. Define the rule of stability using frequency method and draw the frequency curve for a stable and unstable system. Discuss about the response with respect to phase and gain margin. **3**

5A. Explain the need of dead-time compensation and draw the block diagram of a dead-time compensated system. Derive the overall closed loop transfer function by making necessary assumptions. **4**

5B. What do you understand from split range control? Explain with necessary examples and graphs. **3**

5C. What is loop gain? For a temperature process with inflow is controlled with a control valve, prove that the loop gain is dimensionless. **3**

6A. Explain flashing and erosion in control valve. **3**

6B. What is the need of valve positioners? Explain its working with neat diagram. **3**

6C. What is position and velocity form of PID algorithm? Explain with necessary equations and diagram. **4**

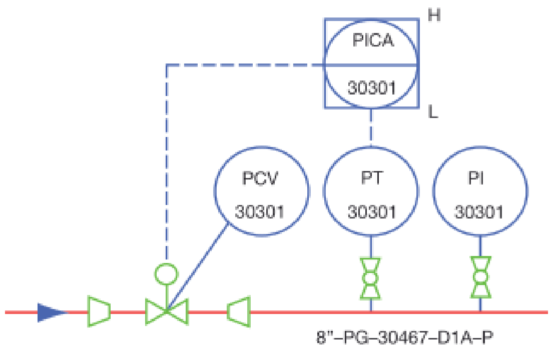

Fig Q2A

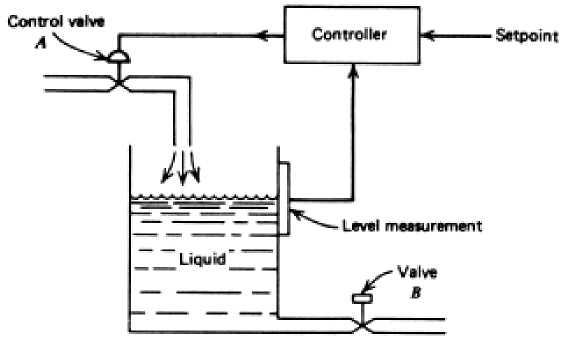

Fig Q3A

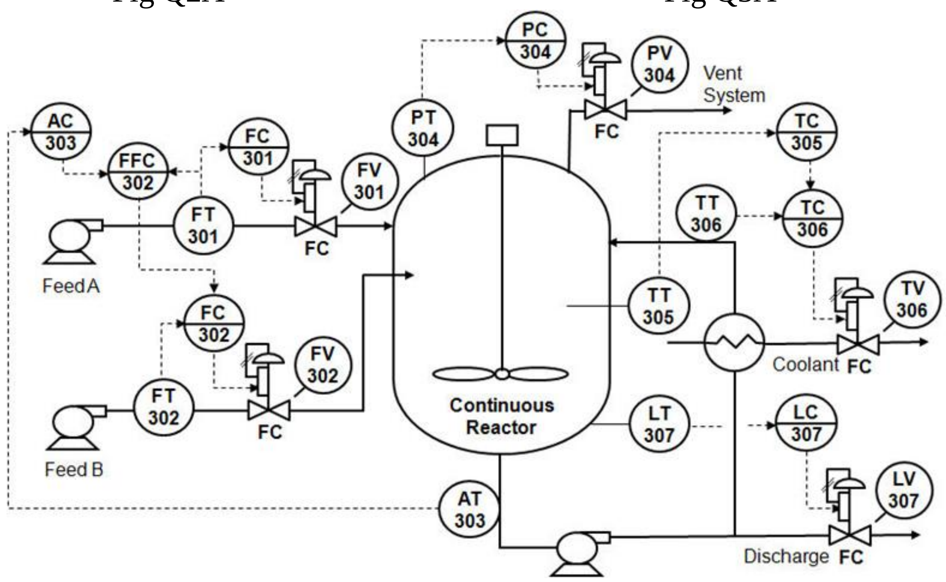

Fig Q2B

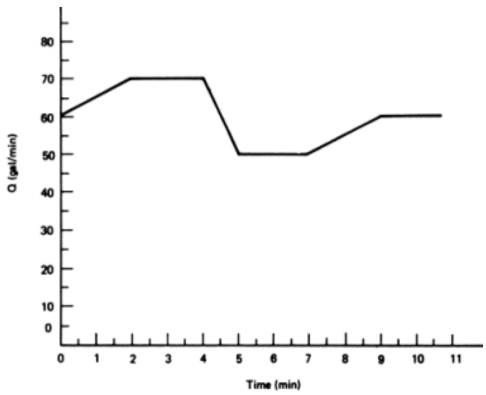

Fig Q4A

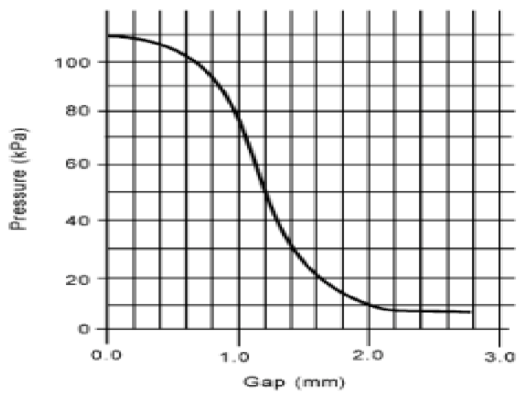

Fig Q4B