

**B. E. (ELECTRICAL ENGINEERING) 5<sup>TH</sup> YR 1<sup>ST</sup> SEMESTER  
SUPPLE EXAMINATION, 2024**

**SUBJECT: - PROCESS INSTRUMENTATION AND CONTROL**

Time: Three hours

Full Marks: 100 (50 marks for each part)

Use a separate Answer-Script for each part

**PART I**

Answer any **THREE** questions. Two marks are reserved for well-organized answers.

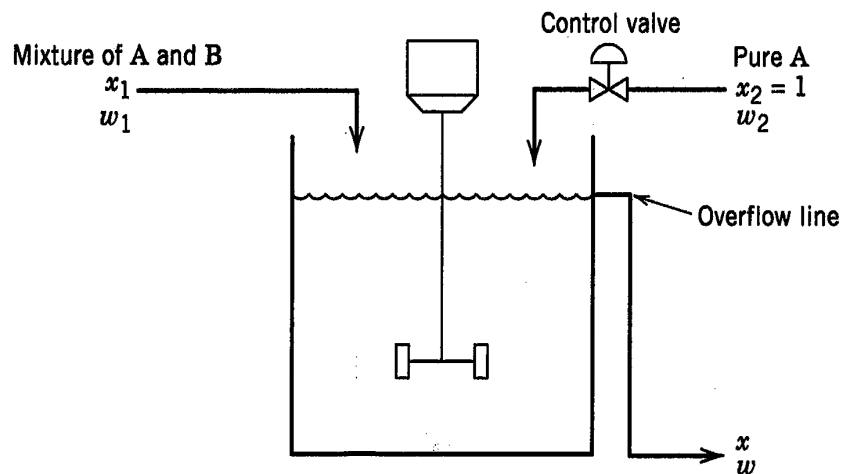
1. a) Draw the instrumentation diagram for the following process: 4+12  
Flow rate in a liquid pipe line is controlled with a local electronic flow controller. The flow signal is obtained from a differential pressure transmitter and a square root extractor. The differential pressure is obtained from an orifice plate in the pipe line.  
b) Prove that in a digital controller  $m_n' = k_p \left( 1 + \frac{\tau}{T_i} \right) e_n - k_p e_{n-1} + m_{n-1}'$   
where  $m_n$  is the controller output sequence and  $e_n$  is the error sequence. Show the input-output relation in block diagram form.
2. With a neat schematic diagram obtain the transfer function of a simple electronic analog PID controller using one OP-AMPS. 16
3. a) Discuss about the spring and diaphragm pneumatic actuator in reverse and direct acting modes. 9+7  
b) What are the basic designs available in rotary valves? List their advantages over conventional globe valves.
4. a) Draw the schematic diagram of a pneumatic PI controller and derive its transfer function. 10+6  
b) State advantage of pneumatic controllers over their electronic counterpart.
5. Write Short notes on any two: 8+8
  - a) Non-Self Regulating Process;
  - b) Spring diaphragm type actuator with positioner;
  - c) Auto/Manual modes with bumpless transfer.

**BACHELOR OF ENGINEERING (ELECTRICAL ENGINEERING)**  
**5<sup>TH</sup> YEAR 1<sup>ST</sup> SEMESTER SUPPLEMENTARY EXAMINATION, 2024**

**Subject: PROCESS INSTRUMENTATION & CONTROL    Time: Three Hours    Full Marks: 100**

**Part II (50 marks)**

- | Question No. | <p><b>Question 1 is compulsory</b><br/> <b>Answer <i>Any Two</i> questions from the rest (2×20)</b></p>  | Marks |
|--------------|--|-------|
| Q1           | Answer <i>any Two</i> of the following:  |       |
| (a)          | With the help of a schematic diagram define the different process variables and control variables associated with an automatic process control system.   | 5     |
| (b)          | What are “Integral Balance” and “Instantaneous Balance” techniques of process modeling? Obtain the model of a “Liquid Surge Tank” using both the methods.  | 2+3   |
| (c)          | What is <i>Process Time Lag</i> ? What are the main factors responsible for it?  | 5     |
| (d)          | With the help of a block diagram discuss the function of a Soft Sensor in an Inferential Control Scheme.   | 5     |
| Q2           | (a) A continuous, stirred-tank blending system is shown in Figure Q2(a).<br>(i) Write down the Steady-State Material and Component-A balance equations.<br>(ii) Obtain the expression for the nominal flow rate of $w_2$ required to produce the desired output concentration $x_{sp}$ .<br>(iii) Suppose that inlet concentration $x_1$ varies with time. What are the different schemes that can be employed to ensure that the outlet composition $x$ remains at or near its desired value $x_{sp}$ ? |       |



4+4+4

- (b) Describe the methods of determining the parameters of First-Order-Plus-Time-Delay (FOPTD) model from the process reaction curve.

8

- Q3 (a) Why PID controller is called a “Gain-Reset-Preact Controller”? 6
- (b) For a type-0 system, explain how PI-controller can eliminate the steady-state offset for a step input while P-controller can only reduce it. 6
- (c) Explain, with an example, why in practical applications feed-forward control is generally used in combination with feedback control. 8
- Q4 (a) What is Ratio Control? 2+6  
With the help of schematic diagram discuss the different Ratio Control methods.
- (b) A Ratio Control scheme is to be used to maintain a stoichiometric ratio of H<sub>2</sub> and N<sub>2</sub> as the feed to an ammonia synthesis reactor. Individual flow controllers will be used for both the H<sub>2</sub> and N<sub>2</sub> streams. 4  
Draw a schematic diagram for the Ratio Control configuration.
- (c) What is *Inferential Control*? 2+6  
With the help of a block diagram discuss the function of a Soft Sensor in an Inferential Control Scheme.
- Q5 Write short note on *any two* of the followings:
- (a) Lumped and Distributed parameter modeling 10
- (b) Ziegler Nichols methods of PID controller tuning 10
- (c) Cascade Control Scheme 10