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**PRESIDENCY UNIVERSITY**

**Bengaluru**

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| **End - Term Examinations – January 2025** |
| **Date:** 08 / 01/ 2025 **Time:** 09:30 am –12:30 pm |

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| **School:** School of Engineering | **Program:** B. Tech in Petroleum Engineering | |
| **Course Code:** PET2005 | **Course Name:** Fundamentals of Instrumentation and Control Engineering | |
| **Semester**: V | **Max Marks**: 100 | **Weightage**: 50% |

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| **CO - Levels** | **CO1** | **CO2** | **CO3** | **CO4** | **CO5** |
| **Marks** | **22** | **24** | **54** | **-** | **-** |

**Instructions:**

1. *Read all questions carefully and answer accordingly.*
2. *Do not write anything on the question paper other than roll number.*

**Part A**

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| **Answer ALL the Questions. Each question carries 2marks. 10Q x 2M=20M** | | | | |
| **1** | List two primary difference between proportional control (P) and proportional-integral (PI) control. | **2 Marks** | **L1** | **CO3** |
| **2** | A proportional controller has a gain Kp=5. If the error signal is 2 units, calculate the control action (output signal of the controller). | **2 Marks** | **L1** | **CO3** |
| **3** | The Unit-step response for set point change of a Proportional controller is shown in above figure. Let say For the case of a unit-step change in set point, *T´* approaches *A*1 = *KcA*/(1 + *KcA*). Find the Offset of the system. | **2 Marks** | **L1** | **CO3** |
| **4** | Recall unity-feedback system with a proper diagram. | **2 Marks** | **L1** | **CO3** |
| **5** | Draw a typical block diagram of a reactor vessel control system and label the components (e.g., Comparator, Controller, Final control element, process, load, and feedback element). Briefly describe the role of the feedback loop in this system. | **2 Marks** | **L1** | **CO3** |
| **6** | Find the transfer function of the closed loop system as shown above while considering **regulator** problem (consider load **U2** only). | **2 Marks** | **L1** | **CO3** |
| **7** | The closed-loop system is provided in the below figure. Recall the transfer function while considering forward path and feedback path. | **2 Marks** | **L1** | **CO3** |
| **8** | Find the overall transfer function while “**n”** number of tanks are connected by noninteracting way. | **2 Marks** | **L1** | **CO 2** |
| **9** | Find the Laplace transform of a function f(t) = e-at.  **(Follow all the steps)** | **2 Marks** | **L1** | **CO2** |
| **10** | The two-tank interacting system is shown in the below diagram. Recall the transfer function of the said system. **(Only write the mathematical expression)** | **2 Marks** | **L1** | **CO1** |

**Part B**

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| **Answer the Questions Total 80 Marks.** | | | | | |
| **11.** | **a.** | The below figure depicts the proportional control system of a heated stirred-tank reactor. The standard symbols for the variables like controller, load, final control element is given in the diagram, as shown below. Develop the relationship of offset when considering servo and regulator problem. **[Do not skip any step]** | **20 Marks** | **L3** | **CO3** |
| **or** | | | | | |
| **12.** | **a.** | Build the block diagram considering each case and find the corresponding transfer function from the block diagrams taking the key components as your wish.  **CASE I:** Let's assume a traffic signal where the signal is changed after a certain time or a particular time slot.  **CASE II:** Let's assume a traffic signal where the signal is changing after a particular time slots and traffic density. | **20 Marks** | **L3** | **CO3** |
|  | **b.** | Using Routh Array test, determine the stability of the system represented by the characteristic equation (3S4 + 10S3 + 5S2 + 5S + 2 = 0) **[Do not skip any step]** | **L3** | **CO3** |
|  |  |  |  |  |  |
| **13.** | **a.** | Two-stirred tank chemical reactor control system is shown in below figure. Develop the transfer function for tank 1 and tank 2, respectively. **[Do not skip any step]** | **20 Marks** | **L3** | **CO3** |
| **or** | | | | | |
| **14.** | **a.** | An open-loop control system is shown in the below figure. A unit step impulse is introduced into the system.   1. Solve the output value at time “t” i.e., Y(t). 2. For the same system identify the system stability by employing Routh array test.     **[Do not omit any steps]** | **20 Marks** | **L3** | **CO3** |

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| **15.** | **a.** | Consider, you have a stirred tank reactor which is controlled by a closed loop system. The reactor temperature was maintained at a constant temperature. In that system the feed forward path transfer function is given by . The feedback transfer function is given by 1. After some times the reactor temperature was change to a certain level by introducing unit impulse into the system. Solve the output response of the given system.  **[First draw the control system as per the question and consider the input and output key component of the system is P(s) and Q(s), respectively]** | **20 Marks** | **L3** | **CO2** |
|  | **b.** | The below diagram shows a closed-loop control system, having an open-loop transfer function of .   1. Develop the closed-loop transfer function. 2. Also identify whether the system is critically damped, over damped, or under damped. 3. From the second order transfer function solve period of oscillation. **[Do not omit any steps]** | **L3** | **CO2** |
| **Or** | | | | | |
| **16.** | **a.** | Develop the transfer function for a first-order system by considering the unsteady-state behavior of an ordinary mercury-in-glass thermometer, as shown above.  **[Do not skip any steps]** | **20 Marks** | **L3** | **CO2** |
|  | **b.** | A thermometer having a time constant of 0.5 minute is at a steady-state temperature of 75°F. At time t=0 the thermometer is placed in a temperature bath and maintained at 100°F. Solve the time needed for the thermometer to read 90°F.  **[Do not skip the steps]** | **L3** | **CO2** |

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| **17.** | **a.** | Explain clearly how block diagrams and feedback principles are combined to analyze and design a control system. **(key components you may consider as per your wish)** | **20 Marks** | **L2** | **CO1** |
|  | **b.** | In block diagram reduction show the following block diagrams **(only draw the block diagrams, no discussion is required)**   1. Combining the blocks in cascade 2. Moving the branch point ahead of the block 3. Moving the branch point before the block 4. Moving summing point ahead of the block 5. Moving summing point ahead of the block | **L2** | **CO1** |
| **Or** | | | | | |
| **18.** | **a.** | The unit step impulse is introduced into the open loop system which is shown in below figure. Solve the output Y(t) from the closed loop system. | **20 Marks** | **L3** | **CO1** |
|  | **b.** | Four stirred tank reactor is connected parallelly as shown in figure below. “G” in the figure represents the process of each tank system. Develop the output transfer function for the following system. |  | **L3** | **CO1** |

**\*\*\*\*\* BEST WISHES \*\*\*\*\***