Name of the Examination: **BIEE 3rd YEAR 1st SEM. EXAMINATION, 2025**

SUBJECT: **PROCESS DYNAMICS AND CONTROL**
(Course code: IEE/PC/B/T/313)

Time: Three hours **Full Marks 100**

List of Course Outcomes (CO):

CO1: Develop mathematical models of typical processes (K3, A2-model)
CO2: Explain and analyse the performance of different controllers and their tuning methods(K4,A2-examine)
CO3: Differentiate between various control schemes and interpret their necessity (K4,A3)
CO4: Explain the role of final control elements in process control systems (K2, A1)

Instructions to the Examinees:

- Each module in the question paper matches up with the corresponding CO
- **Attempt questions for the attainment of all the COs**
- Alternative questions (if any) exist within a module, not across the modules
- Different parts of same question should be answered together

[Turn over

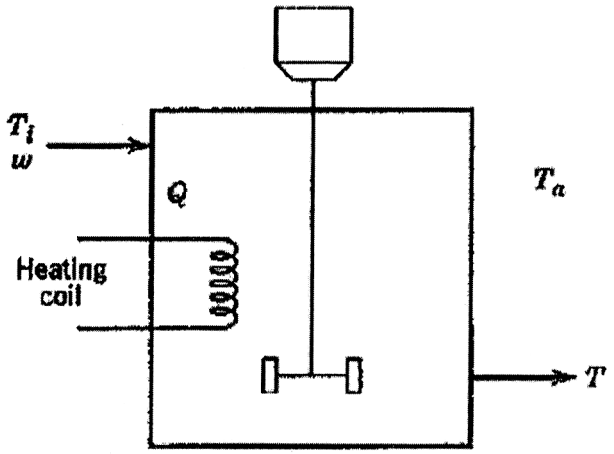
Attempt ALL Questions

Q1A. **3+3+7+4+3**

i) What is the significance of "degree of freedom"?

ii) Why the mathematical modeling for process control is required?

iii) An enclosed stirred tank heating process is used to heat an incoming stream with variable flow rate. The heating rate from this coil and the volume are both constant. w, denote mass flow rate.



a) Develop a mathematical model that describes the exit temperature if heat losses to the ambient occur and if the ambient temperature (T_a) and incoming stream temperature (T_i) both can vary.

b) Discuss qualitatively what you expect to happen as T_i and w varies (increase or decrease) referring your model.

iv) Explain the self regulation process with an example.

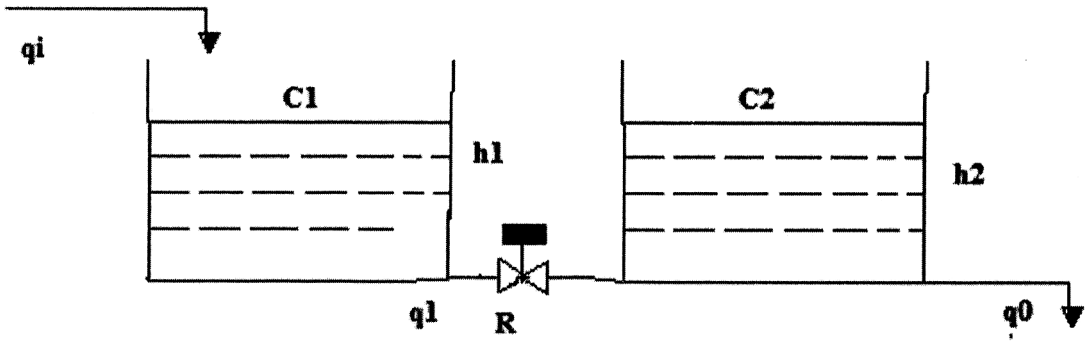
v) Establish the mathematical model for a liquid tank having controlled inflow and controlled outflow with process resistance and capacitance.

OR

Q1B. **7+6+4+3**

i) Describe a simple thermal system in which incoming liquid is heated by the heater in the tank and going out with higher temperature. Develop first order transfer function of the thermal process.

ii) Derive the mathematical model for the given process



iii) Define load variable, control variable, error signal and manipulated variable with an example.

iv) Define process reaction rate.

Q2A. **4+5+6+4+6+5**

i) Define ON-OFF control action with differential gap.

ii) With the dynamic response of ON-OFF controller, explain the significance of using differential band gap in ON-OFF controller.

iii) Establish the relation between proportional gain and proportional band in proportional control action.

iv) Why integral control action is used along with proportional control action?

v) An integral controller with a value of K_I =0.1/s, has an output of 40% PB at the SP. What will be the output after 2S if there is a sudden change to a constant error of 20%.

vi) With a neat sketch explain the different symbols used for piping & instrumentation (P&I) diagrams for a level control loop.

OR

Q2B. **6+5+4+5+6+4**

i) What are the advantages and drawbacks of position algorithm for control action?

ii) Where the derivative control action is required and why?

iii) What are the basic criteria to be satisfied in order to obtain tuning of a controller?

iv) Explain Damped oscillation tuning method by Harriot for PID controller.

v) What is the issue related to integral wind up and how it can be prevented using programmable controller?

vi) Draw the response characteristic of PID control action for a step input.

Q3A. **6+6+5+7+6**

i) What are the advantages and drawbacks of feedback control system.

ii) How process control mechanism can be improved using feedforward control?

iii) Explain the operation of cascade control system.

iv) How the relay based annunciator can operate?

v) Write a short note on override control.

OR

Q3B. **6+6+6+6+6**

i) Explain the operation of a pneumatic pressure transmitter.

ii) Explain the split-range control system with an example.

iii) Give the operating principle of DDC with block diagram.

iv) What is the function of annunciator in plant? Explain the major steps of operation of the annunciation process.

v) With neat diagram explain the operation of smart transmitter.

Q4A. **6+4+4+3+3**

i) Write the advantages and disadvantages of single seated valve.

ii) When would you recommend an air-to-close control valve? Give an example.

iii) What is the advantage of using an equal percentage valve over a linear valve?

iv) Explain the purpose of using valve positioner.

v) Explain the principles of working of I/P converter.

OR

Q4B. **5+5+5+5**

i) Why the installed characteristics of control valve are different from its inherent characteristics?

ii) With a neat diagram explain the operation of spring actuator with positioner.

iii) Define the term rangeability of a control valve and its importance.

iv) How to determine the size of a control valve suitable for an application?