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B.M.S. College of Engineering, Bengaluru-560019

Autonomous Institute Affiliated to VTU

February / March 2023 Semester End Main Examinations

Programme: B.E. **Semester: V**
Branch: Chemical Engineering **Duration: 3 hrs.**
Course Code: 19CH5DCPCE **Max Marks: 100**
Course: Process Control Engineering **Date: 23.02.2023**

Instructions: 1. Answer any FIVE full questions, choosing one full question from each unit.
2. Missing data, if any, may be suitably assumed.

UNIT - I

1 a) Derive a response equation considering a I-order system for a sinusoidal input and draw the response curve. Also, compare the frequency, amplitude and phase angle of the input and response curves. **10**

b) An aqueous solution is mixed in a tank. The density of the solution is 900 kg/m^3. The feed rate is 1.5 m^3/min and the volume of the tank is 1.5 m^3. The steady state concentration of the solution is 0.03 k mol / m^3. The inlet concentration of the feed is suddenly increased to 0.08 k mol/m^3. Calculate the outlet concentration of the solution for t =0.55 min and t = 1 min. **10**

UNIT - II

2 a) Derive the response equation of U-tube manometer for a unit step change in input when the system is over-damped. **08**

b) Comment on the value of damping ratio, nature of the roots and the corresponding type and response of second order systems. **06**

c) Obtain an expression for impulse response of a second order critically damped system. **06**

OR

3 a) The characteristics of a particular instrument is represented by the equation: $100\frac{d^2Y}{dt^2} + 3.2\frac{dY}{dt} + 4\,Y = 20\,X\ with\ Y(0) = Y'(0) = 0$. Find its transfer function. Identify the time constant, damping coefficient and gain. **08**

b) A control system has the transfer function G(s) = 5/(25 s^2 + 0.8 s + 1). Find the response Y(t) , if X(t) = 6 u(t); draw a sketch of Y(t). Does the response show a maximum and period of oscillation? If so, estimate and indicate their numerical values in the sketch **12**

UNIT - III

4 a) Write the basic equation relating controller output with error signal. Proportional controller **06**

i) Proportional Derivative controller

ii) Proportional Integral Derivative controller

b) A PID controller is subjected to sinusoidal change in error, Asinωt. Sketch the response of the controller. **10**

Data: $\tau_I = 60\ sec, \tau_D = 30\ sec$, Kc = 4, A = 5^0C, ω =0.3 rad/sec.

c) What is an actuator? List the various types of actuators that are used in automatic process control. **04**

UNIT - IV

5 a) Draw the block diagram of a positive feedback servo problem labelling all the components. Also, derive the transfer function of the same. **08**

b) The major elements of a closed loop control system is having following transfer functions **12**

$G_p(s) = \frac{2.5}{(s+1)(2s+1)}$

Gc (s) = Kc

Transfer function for the rest of the components in the loop are unity. All time constants are in minutes. Determine the transient response for a unit step input in set point at a controller gain that made the system critically damped.

UNIT - V

6 a) Explain the procedure to construct the Routh Array and finding the roots on the imaginary axis. **10**

b) Given the Characteristic equation, **10**

$s^8+2s^7+8s^6+12s^5+20s^4+16s^3+16s^2 = 0$, Construct the Routh array and comment on the stability and location of roots on s-plane.

OR

7 a) A feedback transfer system has open loop transfer function **10**

$G(s) = \frac{K(s+1)}{s(s+2)(s+3)(s+5)}$. Sketch the root locus.

b) Give step wise procedure of Ziegler-Nichols tuning technique for feedback controllers. **10**

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