

# INDIAN INSTITUTE OF TECHNOLOGY-KHARAGPUR

Mid-Spring Semester 2015-16 (Closed Book)

Course No.: CH 61016

Course Title: Process Dynamics and Control

Max. Time: 2 hrs

Total Marks: 30

**Answer all questions**

1. (a) What are the different types of control affine models? [2+4+9 = 15]
- (b) Elaborate the steps of building control affine models from the dynamic model of a process.
- (c) Realise state space model in (i) controllable canonical form (ii) observable canonical form (iii) Jordan canonical form from the transfer function  $G(s) = \frac{2s^2 + 3s + 1}{48s^3 + 44s^2 + 12s + 1}$
2. (a) Consider a liquid level system shown in Fig. 1. The level ( $h$ ) is controlled by manipulating the outlet flow rate ( $F_2$ ) with the use of a P-only controller that has a variable proportional gain as  $K_C = K_{CO}|e|$ . Discuss the tuning of  $K_{CO}$  with developing a suitable correlation for it based on the regulatory performance.

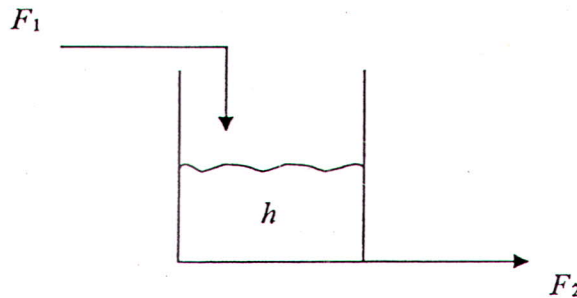


Fig. 1. Liquid level system.

- (b) What is the basic difference between the cascade and the feedforward-feedback combined control scheme in terms of their application? [3+1+3+3+5 = 15]
- (c) Discuss a control scheme, which offers a constant process gain, for maintaining the stoichiometric proportion in a chemical reactor.
- (d) Develop an exponential data filtering system to show how its time constant affects the noise and closed-loop response.
- (e) Consider a process with the following transfer functions for its primary and secondary elements:

$$\text{Primary element: } G_{p1} = \frac{1}{(5s+1)(10s+1)} \quad \text{Secondary element: } G_{p2} = \frac{1}{(s+1)}$$

$$\text{with } G_{m1} = G_{m2} = G_f = 1$$

Tune the cascade control scheme using the PI controller for primary loop and the P-only controller for secondary loop.