Reg. No.										

MANIPAL INSTITUTE OF TECHNOLOGY

MANIPAL

A Constituent Institution of Manipal University

I SEMESTER M.TECH. (CHEMICAL ENGINEERING)

END SEMESTER EXAMINATIONS, NOVEMBER 2017

SUBJECT: Advanced Process Dynamics & Control [CHE5104]

REVISED CREDIT SYSTEM

Time: 3 Hours MAX. MARKS: 50

Instructions to Candidates:

- Answer **ALL** questions.
- Missing data may be suitably assumed.

1A.	Distinguish between Feedback control and Feedforward control schemes with suitable examples.	**4**
1B.	Design a controller incorporating a smith predictor for a time delay process. Discuss the merits and de-merits of the same.	**4**
1C	Discuss the various soft sensing methods existing in the literature.	**2**
2A.	Explain the detailed procedure of designing a de-coupler for 2x2 system. You are expected to show the block diagram of 2x2 system with decoupler.	**6**
2B.	The dynamic model of Process is as follows, $$M_1 \frac{d^2 x_1}{dt^2} + D\frac{dx_1}{dt} + K(x_1 - x_2) = 0$$ $$M_2 \frac{d^2 x_2}{dt^2} + K(x_2 - x_1) = f(t)$$ Obtain the state space model of the form, $$\dot{x} = Ax(k) + Bu(k)$$ $$y = Cx(k)$$	**4**
3A	The characteristic equation for a certain closed loop digital control system is given as: $$1 + 0.3z^{-1} - 0.2z^{-2} - 0.2z^{-3} + 0.4z^{-4} = 0$$ Using Jury's method determine whether this system is stable or not.	**04**
3B.	Consider moving average (MA) process $$y(k) = H(q)e(k); \qquad H(q) = 1 - 1.1q^{-1} + 0.3q^{-2}$$ Compute $H^{-1}(q)$ as an infinite expansion by long division and develop an auto-regressive model of the form $e(k) = H^{-1}(q)y(k)$. Show that this model facilitates estimation of noise *e(k)* based on current and past measurements of *y(k)*	**04**
3C	Discuss the different condition for stability of linear discrete time state space model.	**02**

4A	Derive the parameter estimation problem for output error model structure given below. You are expected to demonstrate all the steps. $$x(k) = \frac{b_1 q^{-1} + b_2 q^{-2}}{1 + a_1 q^{-1} + a_2 q^{-2}} q^{-1} u(k)$$ $$y(k) = x(k) + v(k)$$	**04**
4B	Consider the following system $$x(k+1) = \begin{bmatrix} 1/4 & 1/4 \\ -1/4 & 0 \end{bmatrix} x(k) + \begin{bmatrix} -2 \\ 1 \end{bmatrix} u(k) + w(k);\ \ y(k) = \begin{bmatrix} 1 & 0 \end{bmatrix} x(k) + v(k)$$ It is desired to develop a state feed feedback control law of the form $u(k) = -Gx(k)$. Find the matrix 'G' such that the poles of $(\Phi - \Gamma K)$ are placed at $\lambda = -0.25 \pm j0.25$	**06**
5A.	Consider fourth order system as $$y(k) = G(q)u(k) = \frac{b_1 q^3 + b_2 q^2 + b_3 q + b_4}{q^4 + a_1 q^3 + a_2 q^2 + a_3 q + a_4},$$ Obtain the state space realization (controllable canonical) of the form $$x(k+1) = \Phi x(k) + \Gamma u(k)$$ $$y(k) = Cx(k)$$ Such that, $C\left[qI - \Phi\right]^{-1} = G(q)$.	**04**
5B	Luenberger state estimator is to be designed by considering the plant as $$x(k+1) = \Phi x(k) + \Gamma u(k); \qquad y(k) = Cx(k)$$ Develop an error dynamics and discuss the merits and demits of this observer.	**04**
5C	Discuss the working principle of model predictive control strategy.	**02**

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