Reg. No.										

MANIPAL INSTITUTE OF TECHNOLOGY
MANIPAL

A Constituent Institution of Manipal University

VII SEMESTER B.TECH. (CHEMICAL ENGINEERING)

END SEMESTER EXAMINATIONS, NOV/DEC 2016

SUBJECT: ADVNACED PROCESS DYNAMICS AND CONTROL [CHE443]

REVISED CREDIT SYSTEM

Time: 3 Hours MAX. MARKS: 100

Instructions to Candidates:

- Answer **ANY FIVE FULL** questions.
- Missing data may be suitable assumed.

1A.	Discuss the various soft sensing methods existing in the literature.	**06**
1B.	Discuss the different adaptive control strategy.	**06**
1C.	Design a controller for the following system, $G_p(s) = \frac{1}{(2s+1)(5s+1)}$ Using the direct synthesis approach, given a desired closed loop behavior is $q(s) = \frac{1}{(\tau_r s+1)}$ with (a) τ_r =5 and (b) τ_r =1. Compare the results of (a) with (b) with respect controller response.	**08**
2A.	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.	**08**
2B.	Consider moving average (MA) process $$y(k)=H(q)e(k); \quad H(q)=1-1.1q^{-1}+0.3q^{-2}$$ 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 $y(k)$	**06**
2C.	Obtain the pulse transfer function (y(z)/u(z)) model for the given linear difference equation model $$y(k)+0.8y(k-1)+0.2y(k-2)=0.8u(k-1)+0.3u(k-2).$$ Find y(k) for k=0,1,2,3,4,5., from the pulse transfer function by long division.	**06**
3A.	Derive the parameter estimation problem for output error model structure given below. You are expected to demonstrate all the steps. $$\mathrm{x}(k)=\frac{b_1q^{-1}+b_2q^{-2}}{1+a_1q^{-1}+a_2q^{-2}}\mathrm{q}^{-1}\mathrm{u}(k)\,; \quad \mathrm{y}(k)=\mathrm{x}(k)+\mathrm{v}(k)$$	**08**
3B.	Design a controller incorporating a smith predictor for a time delay process..	**06**
3C.	Explain the detailed procedure of designing de-coupler for 2x2 system. You are expected to show the block diagram of 2x2 system with decoupler.	**06**
4A	A certain multivariable system has three outputs y_1, y_2 and y_3 which can be controlled by any	**08**

	of four available inputs m_1, m_2, m_3 and m_4. Through pulse testing, the following 3x4 transfer function matrix model was obtained. Which input / output pairing confguration is expected to give the best results for a multiple single loop strategy? $$\begin{bmatrix} y_1 \\ y_2 \\ y_3 \end{bmatrix} = \begin{bmatrix} \frac{0.5e^{-0.2s}}{3s+1} & \frac{0.07e^{-0.3s}}{2.5s+1} & \frac{0.04e^{-0.3s}}{2.5s+1} & \frac{0.01e^{-0.5s}}{10s+1} \\ 0 & 0 & 0 & \frac{0.5e^{-0.1s}}{2.1s+1} \\ \frac{0.004e^{-0.5s}}{1.5s+1} & \frac{-0.003e^{-0.2s}}{s+1} & \frac{-0.006e^{-0.4s}}{1.6s+1} & 0 \end{bmatrix} \begin{bmatrix} m_1 \\ m_2 \\ m_3 \\ m_4 \end{bmatrix}$$	
4B.	Consider the following system $$x(k+1) = \begin{bmatrix} 1/4 & 1/4 \\ -1/4 & 0 \end{bmatrix} x(k) + \begin{bmatrix} -2 \\ 1 \end{bmatrix} u(k) + w(k); \quad y(k) = \begin{bmatrix} 1 & 0 \end{bmatrix} x(k) + v(k)$$ 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 $\lambda = -0.25 \pm j0.25$	**12**
5A.	Discuss the different condition for stability of linear discrete time state space model.	**06**
5B.	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, $C[qI - \Phi]^{-1} = G(q)$.	**08**
5C.	Define observability of a system. Consider a discrete time system as $$\begin{bmatrix} x_1(k+1) \\ x_2(k=1) \end{bmatrix} = \begin{bmatrix} 1/2 & 1 \\ -1/2 & 0 \end{bmatrix} \begin{bmatrix} x_1(k) \\ x_2(k) \end{bmatrix} + \begin{bmatrix} 1 \\ -2 \end{bmatrix} u(k)\ ; y(k) = \begin{bmatrix} 1 & 0 \end{bmatrix} \begin{bmatrix} x_1(k) \\ x_2(k) \end{bmatrix} + v(k)$$ Is this system observable?	**06**
6A.	Consider second order ARX model with d=2 $$y(k) = a_1 y(k-1) - a_2 y(k-2) + b_1 u(k-3) + b_2 u(k-4) + e(k)$$ Develop a parameter estimation problem and present the solution to the above through least square optimization. You are expected to demonstrate all the steps.	**08**
6B.	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**
6C.	Discuss the working principle of model predictive control strategy.	**08**

****