Reg. No.										

MANIPAL INSTITUTE OF TECHNOLOGY
MANIPAL
(A constituent unit of MAHE, Manipal)

I SEMESTER M.TECH. (CHEMICAL ENGINEERING)

END SEMESTER EXAMINATIONS, NOVEMBER/DECEMBER 2018

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.	Design a controller incorporating a smith predictor for a time delay process and comments on the controller.	**03**
1B	Explain the application of soft sensor in process industry with an example.	**03**
1C	Explain the different Adaptive control algorithm schemes with block diagram	**04**
2A	Design a controller for the following plant, $G_p(s) = \frac{1}{(2s+1)(5s+1)}$ Using the direct synthesis approach, given 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 to controller response.	**03**
2B.	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.	**04**
2C	The dynamic model of process is as follows, $M_1 \frac{d^2x_1}{dt^2} + D\frac{dx_1}{dt} + K(x_1 - x_2) = 0$ $M_2 \frac{d^2x_2}{dt^2} + K(x_2 - x_1) = f(t)$ Obtain the state space model of the form, $\dot{x} = Ax(k) + Bu(k); \quad y = Cx(k)$	**03**
3A	First order system expressed using a difference equation is as follows, $y(k+) + a_1 y(k-1) = b_1 u(k-1)$ Develop its pulse transfer function and Calculate the response (y(k), k=0,1,2,3,4) for unit step	**4**

	input (given a_1=-0.368 and b_1=1.264) using z-transform	
3B	The characteristic equation for a certain closed loop digital control system is given as: $$1+0.2z^{-1}-0.2z^{-2}-0.2z^{-3}+0.5z^{-4}=0$$ Using Jury's method determine the stability of the system.	**4**
3C	Discuss the different condition for stability of linear discrete time state space model	**2**
4A	Consider a 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 $y(k)$	**4**
4B.	Derive the parameter estimation problem for output error model structure given below. You are expected to demonstrate all the steps. $$\mathrm{x}(k) = \frac{b_1q^{-1}+b_2q^{-2}}{1+a_1q^{-1}+a_2q^{-2}}\mathrm{q}^{-3}\mathrm{u}(k)$$ $$\mathrm{y}(k) = \mathrm{x}(k)+\mathrm{v}(k)$$	**4**
4C	Consider fourth order system as $$y(k)= G(q)u(k)= \frac{b_1q^3+b_2q^2+b_3q+b_4}{q^4+a_1q^3+a_2q^2+a_3q+a_4},$$ Obtain the state space realization (controllable canonical) of the form $$x(k+1)=\Phi x(k)+\Gamma u(k); \;\; y(k)=Cx(k) \quad \text{such that } C\left[qI-\Phi\right]^{-1}=G(q)$$	**2**
5A	Consider the following system $$x(k+1)=\begin{bmatrix}0.3 & 0.3\\ -1/4 & 1.0\end{bmatrix}x(k)+\begin{bmatrix}-2\\ 2\end{bmatrix}u(k)+w(k)$$ $$y(k)=\begin{bmatrix}1 & 0\end{bmatrix}x(k)+v(k)$$ 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 $\lambda=-0.25\pm j0.25$	**5**
5B.	Design a Luenberger state estimator 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 demerits of this observer.	**5**

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