Masters of Mechanical & Automobile Engineering 1st Year 2nd Semester Examination

Subject: Control of Mechatronic Systems

Time : Three hours **Full Marks: 100**

Answer any **FOUR** *questions.*

1. Why is a mechatronic system so called? Explain the role of its different subsystems including a controller with the help of a block diagram. Explain the term disturbance with reference to governing the turbine speed of a power plant and the control of temperature and pressure in a furnace. **4+15+6**
2. How does a servovalve differ from a proportional valve? Draw an EHAS with a dual-tandem cylinder. Why is it preferred in an aircraft? **5+15+5**
3. What is the basis of evolving a fuzzy control and what kind of uncertainty is dealt with by it? The Gaussian membership functions of the sum x of the nondimensional error e and its rate *de/dt* involve three sets, namely 1, 2 and 3, which have membership value of 1.0 respectively at -2.0, 0 and 2.0 and acquire membership value of 0.5 respectively at -3.0, 1.0 and 3.0. For the output variable u, the fuzzy sets are singleton membership value of 1.0 at -2, 0 and 2 for the subsets 1, 2, and 3 respectively. The rule base is: if x is i then u is i for i=1 to 3. Determine the output for e and *de/dt* respectively equal to 0.5 and -1.8. **5+20**
4. a) What are the roles of feedforward, P and I controls in a combined feedforward-PI controller design for a nonlinear system? **6**

   b) Find an expression for the feedforward command and the corresponding minimum recommended P and D gains for the nonlinear system

   $\ddot{x}+a\dot{x}=a\dot{x}+ku^2/(x_0-x)^2$

   with output $y=x$ and the command u. **9+10**

5. a) What are meant by 1-SMC and 2-SMC? What is the role of Routh coefficients in defining the sliding variable? **4+3**

   b) Consider a first order dynamic system $\dot{x}=u+d$, $u=\alpha\text{sgn}(x)$, $|d|<C$ and $\alpha>C$ where x, u and d are the output error, input signal and the disturbance respectively. For an initial point on the positive side of the x-axis in the x–$\dot{x}$ phase-plane, draw the system trajectory with proper explanations. Also determine the time to reach the sliding surface. **12+6**
6. With the help of an example, explain the method of selection of candidates in a subsequent generation during execution of genetic algorithm. What are the roles of crossover and mutation in such an algorithm? **17+8**