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M.E.E. & M. CONTROL SYSTEM ENGG. 1ST SEM. EXAMINATION - 2017

MODELING AND SIMULATION OF DYNAMIC SYSTEMS

Time: Three Hours | Full Marks: 100

Answer ***any five*** questions

1. a) State the qualities of an efficient random number generator. 5+15

   b) Given the following sequence of 100 random numbers:

   62, 38, 71, 35, 14, 54, 70, 18, 38, 65, 56, 49, 10, 19, 74, 15, 66, 63, 20, 29, 70, 25, 54, 40, 54, 70, 86, 30, 48, 82, 33, 42, 91, 40, 36, 39, 45, 55, 18, 86, 22, 97, 80, 06, 21, 33, 02, 05, 24, 14, 20, 78, 35, 25, 72, 42, 30, 66, 49, 39, 57, 60, 94, 29, 07, 05, 96, 14, 10, 20, 18, 15, 84, 28, 01, 28, 90, 78, 30, 07, 88, 27, 50, 90, 35, 95, 92, 50, 42, 77, 55, 37. 95, 33, 84, 66, 90, 54, 35, 43.

   Calculate the value of χ^2 by performing the Chi-square test for
   (i) uniformity (assume 10 classes).
   (ii) autocorrelation (assume 9 classes).

2. a) Solve the following integral by generating a sequence of 50 random numbers with your calculator 8+7+5

$$I = 4\int_{2}^{5} x^3 dx$$

   b) Write a flow-chart for the generation of a sequence of four digit random numbers with a given seed using the mid-square random number generator.

   c) With a seed of 8763, generate a sequence of 10 random numbers by using the mid-square random number generation method.

3. An inverted pendulum is affected by a control force F acting on the cart. The angular deviation of the pendulum from the vertical is θ. 5+5+10
   a) Draw a free body diagram of (i) the cart and (ii) the pendulum. Clearly define all symbols used and state any assumptions made.
   b) Write the differential equations for the above system.
   c) Obtain the linearized state model for the above system.

4. a) What is a Queuing Discrete Event System? 4+10+6

   b) A fast food restaurant has a Menu Board where a person arriving at the restaurant must place his order, and an Order Pick-up Window where the customer must pay and get the food which he has ordered. The allowable queue length for the menu counter and the order pick-up window are four and three respectively. Draw a flow chart for the above system.

   c) Explain the following terms: *entity*, *attribute*, *server*.

5. a) Write the truth table for an S-R Latch and implement it by using ladder logic. 8+(4x3)
   b) A conveyor belt ferries iron ore between two stations A and B. Assume that when the OFF button is pressed, the belt stops at its current location. (i) Draw a neat schematic diagram for the system described above. (ii) Draw a state transition diagram for the above system clearly stating any assumptions made (iii) Draw a ladder logic diagram for the system

6. A simplified representation of a two-car railroad train moving in the horizontal direction is shown in Fig. 1. The cars are represented by masses M_1 and M_2 and are coupled as shown. The displacements of the masses are denoted by y_1 and y_2 respectively and the velocities are represented by u_1 and u_2 respectively. $f(t)$ is the force acting on M_2 as shown. Unless otherwise mentioned, the symbols have their usual meanings. 12+8
   a) Assuming that the viscous force at mass M_1 is proportional to the square of the velocity of the mass M_1, determine the state space model for this system.
   b) Linearize the model obtained assuming a suitable nominal point.

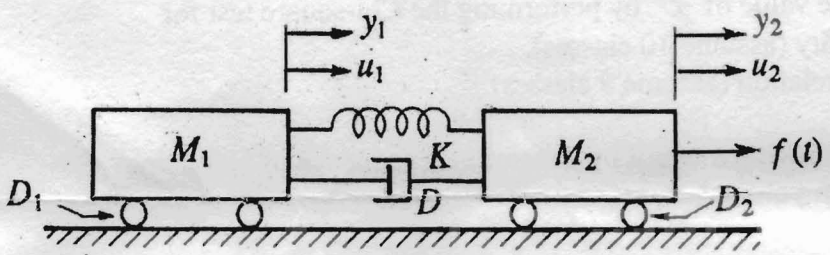

Fig. 1

7. a) Obtain the equivalent state space representation for two models that are connected in cascade form. (Assume that the individual models representing the systems are known in state variable form.) 8+12
   b) For the nonlinear two-tank system shown in Fig. 2, given that $Q_2 = C_f\sqrt{(H_1 - H_2)}$. A_1 and A_2 are the cross-sectional areas of the two cylindrical tanks as shown. (i) Obtain the nonlinear state space representation of the system. (ii) Linearize the model about $H_1 = \tilde{H}_1, H_2 = \tilde{H}_2, Q_1 = \tilde{Q}_1, Q_3 = \tilde{Q}_3$.

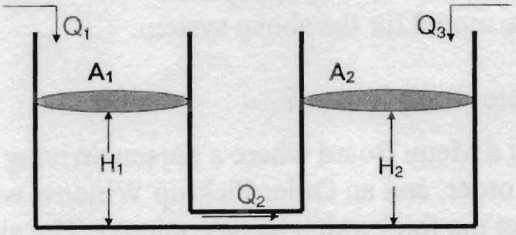

Fig. 2

8. a) Draw a flowchart indicating the steps involved in evolving a model of a physical system. 5+5+10

b) State the advantages of simulation.

c) Given $\frac{dy}{dx} = 1 + y^2 + x^3;\ y(1) = -4,\ h = 0.1.$

Obtain a solution of the above differential equation by using the Euler's method for 3 steps.