M.E. (Electrical) 2nd Semester Final Examination, 2014

Microprocessors in Instrumentation, Monitoring and Control (EE-1035)

Time : 3 hours **Full Marks : 70**

Answer any ***three*** questions taking **two** from Group A and ***one*** from Group B
One mark is reserved for brief and precise answers.

Group A

1. a) What are the principal sources of error in direct frequency measurements? How are these errors reduced?
   b) Explain the principle of wide-range frequency measurement where measurement time and accuracy are both constant. Also describe the operation of a practical instrument for measuring frequency in the range of 10 Hz to 1 GHz working in the above principle with a suitable block diagram.
   c) What is "hazard" in a digital circuit? How "hazard-free" output can be obtained?
   d) Show that the function $(A+C)(B+\overline{C})$ will result in a circuit containing hazards, and that the expression is equivalent to some other expression which produces hazard-free output. Draw a circuit for that expression. [5+9+4+5]

2. a) How 'analog' and 'logic' noises are produced in an instrumentation circuit? How are these eliminated?
   b) What are 'Fan-in' and 'Fan-out' in logic circuits? Give the fan-out values and typical operating frequencies of the TTL, CMOS and ECL families.
   c) If the most significant bit of a unipolar 6 bit successive approximation A/D converter produces a 5V output, show the control register outputs and DAC outputs until an analog signal of 3.3V has been converted.
   d) What are the various data transfer techniques used in instrumentation systems? Explain the operation of DMA. [7+5++5+6]

3. a) What is a GPIB interface? Discuss its hardware specifications. What are the functions of handshake lines? Give the timing diagram of handshake lines. How the device on the bus differentiates between a data and a command?
   b) Explain the differences between polling and interrupt.
   c) Polling scan on a digital computer takes 500 μs to scan 50 points, and an interrupt service procedure on the same machine takes 50 μs per point. If data is produced from an ADC every 2 ms with a data latency of 1.9 ms, compare the above two methods with respect to the software overhead.
   d) Explain the following processes: i) termination ii) static signal conditioning [10+4+5+4]

Group B

4. a) What is 'Distributed Control System'? With a simple block diagram, show how different functionalities of a factory can be handled through such a system. Mention one disadvantage of this system.
   b) What are the commonly used voltage levels in electromechanical contactors? Briefly explain the working principle of one such contactor.
   c) Draw a ladder diagram to implement the function of a dc motor starter on a PLC. Incorporate Start, Stop, Overload, Loss of Field operations. The starter should be a 4-point starter. [(2+4+2)+(3+4)+8]

5. a) Realize the following digital function involving three logic variables, using a PLA, a PAL and an FPGA (three different circuits):

   $$F = xy + y\bar{z} + x\bar{y}z$$

   Point out the differences between the three classes of devices mentioned above and explain why the FPGA has replaced the former two types almost entirely.
   b) What basic logic function is implemented in Actel (FPGA) logic module? Explain.
   c) In a hypothetical system having one state variable x_1 and one input u_1, if

   $$dx_1/dt = 2*x_1 + u_1,$$

   design an FPGA-based circuit to solve for x_1. Use any integration method. Show the timing details.
   d) What are real-time systems? Are PLC-based systems real-time? What are the essential components of a real-time system? [(6+2+1)+3+(4+2)+(2+1+2)]
