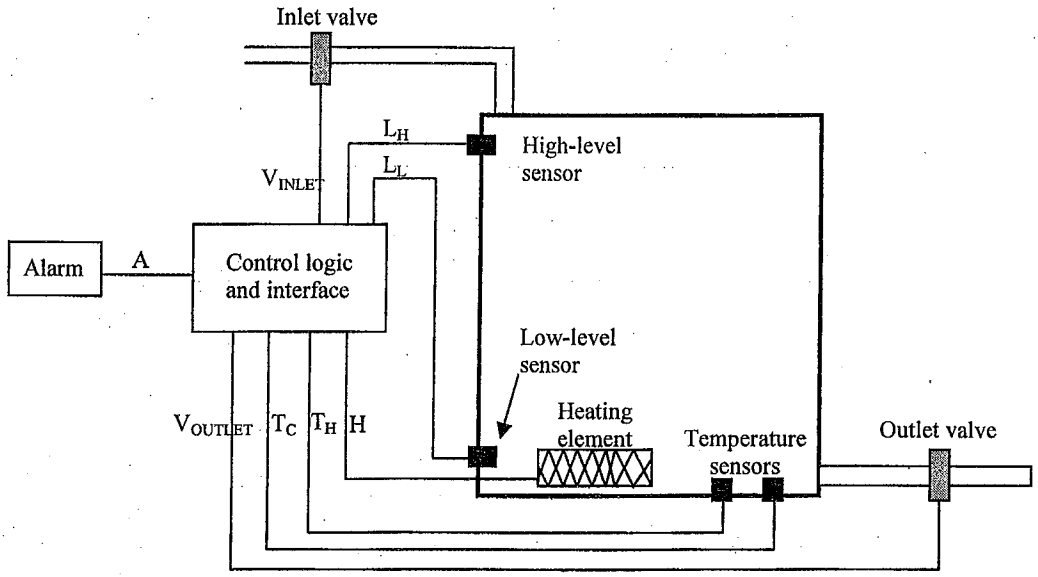
Uva Wellassa University of Sri Lanka
Faculty of Science and Technology
Science and Technology Degree Programme
3rd Year 2nd Semester Examination –August/September 2014

Uva Wellassa University

SCT 366-2 Digital and Analog Electronics

Number of questions: Four (04)
Answer all questions
Time allocation: Two (02) hours
Total marks allocated: 100

1.



You are asked to design digital control logic for controlling the fluid in a storage tank. The purpose of the logic is to maintain an appropriate level of fluid by controlling the inlet and outlet valves. Also the logic must control the temperature of the fluid within a certain range and issue an alarm if any of the level or temperature sensors fail.

Basic Operation – The maximum and minimum fluid levels are determined by the positions of the level sensors in the tank. Each of the level sensors activate when they immersed in fluid. The control logic operates an inlet valve that allows fluid to flow into the tank until a high-level sensor is activated by being immersed in fluid. The control logic closes the inlet valve when the high-level sensor immersed (activated) in fluid or any fault (sensor error) condition is detected. The fluid must be within a specified temperature range before the outlet valve is opened. T_H will be activated when the fluid is too hot and T_C will be activated when the fluid is too cold. The control logic turn on a heating element when a too-cold condition is indicated; otherwise, the heating element is turned off. When a too-hot condition is indicated, an alarm is activated. The output valve is opened when the fluid is in the proper temperature range and fluid level is above the lower level. The alarm will be activated when any fault (sensor error) or too-hot condition is detected by the control logic.

(a) Identify what the inputs to the control logic are and state the condition to activate (produce "High" logic level) each input.

(b) Identify what the outputs from the control logic are and state the operation behavior of the outputs when they are activated by the control logic.

(c) Create a Truth table for tank control logic.

(d) Design a simplified logic circuit for inlet valve.

(e) Design a simplified logic circuit for outlet valve.

(30 marks)

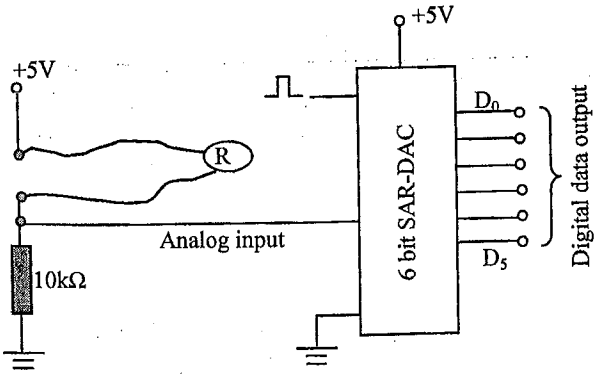
2. (a) Design an asynchronous decade (0-9 in decimal) counter using J-K flip-flops having Clear ($\overline{CLR}$) and Preset ($\overline{PRE}$) inputs.

(b) Make necessary modifications to your counter in order to count from 0010_B, up to 1001_B and then reset back to 0010_B and draw the timing diagram for modified counter.

(25 marks)

3. (a) Explain the operation of 4 bit Successive-Approximation Analog to Digital Converter (SAR-ADC) by taking an example.

(b) The manager of Haputale tea factory wants to monitor temperature of hot air stream used to dry tea leaves. A thermistor (Thermistors are resistors which are sensitive to heat - i.e. their electrical resistance changes as the temperature changes which leads to change the potential across the thermistor of a potential divider circuit), 6 bit SAR-ADC and other necessary electronic components were used to build this system as shown in following figure. The maximum reference voltage of the particular ADC was 5V. At a particular temperature the analog input to the ADC was 3.701V. Step by step find the final digital output from the SAR-ADC corresponds to the above input voltage and calculate the R (resistance of the thermistor) value.

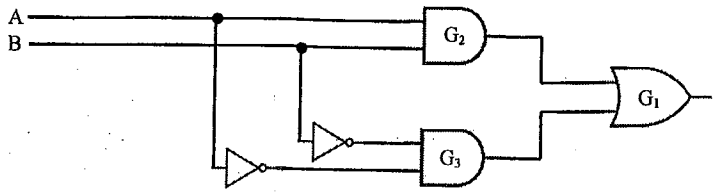


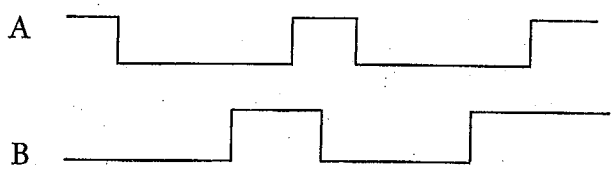
(25 marks)

4. (a) List three advantages of digital circuits over analog circuits. Justify your answer very briefly.

(b) Explain the propagation delay of a gate using a suitable timing diagram.

(c) Draw the timing diagram for the following circuit showing the outputs of G_1, G_2 and G_3 with the input waveforms, A, and B, as indicated. (Do not consider the propagation delay).





(d) Simplify the Boolean expression $[AB(C + \overline{BD}) + \overline{AB}]CD$

(20 marks)

Z3