

The Open University of Sri Lanka
B.Sc. Degree Programme- Level 05
Final Examination 2010

PHU 3150/PHE 5150- Data Acquisition and Signal Processing

Duration: Two and a Half (2 ½) Hours

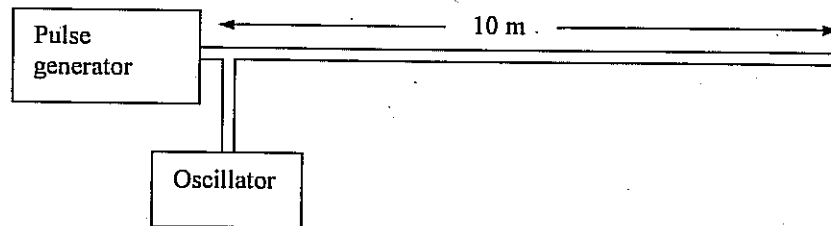
Date: 22.12.2010

Time: 09.30 a.m. – 12.00 p.m.

ANSWER FOUR QUESTIONS ONLY. (Speed of light, $c = 2.99793 \times 10^8 \text{ ms}^{-1}$)

- 1.(a) Briefly explain the tasks of a transducer in a computer aided data acquisition system.
- (b) Write down one sensor each for temperature, light, displacement, and force that changes its resistance upon the act of the physical variable.
- (c) Derive expressions for the output voltage of (i) a voltage divider circuit and (ii) a bridge circuit when one arm is replaced by one of the above resistive transducers.
- (d) Hence, show that the output voltages of the voltage divider circuit and bridge circuit are $V_o = \frac{1+Ge}{2+Ge} V_i$ and $V_o = \frac{Ge}{4+2Ge} V_i$ respectively, when a resistive strain gauge is connected. The gauge factor G of a strain gauge is defined as $G = \frac{\Delta R/R}{e}$, where e is the strain.
- (e) If two identical strain gauges were used in the opposite arms of a bridge circuit, show that the output voltage will be doubled when compared to the output voltage of the bridge circuit with a single strain gauge in part (d).
- 2.(a) What is meant by a delay line? In practice, what is used as delay lines?
- (b) Briefly explain three applications of delay lines.
- (c) Suppose a delay line of characteristic impedance Z_0 and length l is terminated with an impedance Z . If a unit step signal is sent through the delay line, show that the reflection factor ρ at the end of the cable is $\rho = \frac{Z/Z_0 - 1}{Z_0/Z + 1}$.
- (d) Hence show that if the cable is short circuited at the end $\rho = -1$ and if cable is open circuited $\rho = 1$.

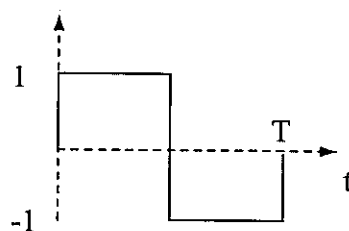
- (e) One end of a 10 m long cable is connected to a pulse generator and an oscilloscope as shown in the following figure. The pulse generator produces 10 ns pulses at a rate of 1 kHz. Calculate the separation between the two pulses observed on the oscilloscope if the cable is open circuited at the end. Suppose two pulses of opposite polarity and approximately of the same height are observed 50 ns apart on the oscilloscope. Determine the type of the damage to the cable and its location. Assume signal propagation velocity of the cable is 0.2 m/ns in your calculations.



- 3 (a) Briefly explain why the spectrum analysis is necessary at the signal processing stage of a data acquisition system.
- (b) Draw the waveform $f(t)$ given below and Fourier transform of that signal.

$$f(t) = \begin{cases} 2 & \text{if } 0 < t < T/2 \\ 1 & \text{if } T/2 < t < T \end{cases}$$

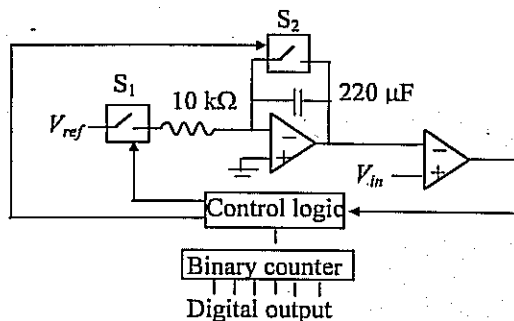
- (c) Plot the power spectrum of this signal.
- (d) If you have the following square waveform, draw a suitable circuit to clamp this signal to 0 V.



- (e) Suppose you need to get the wave form in (b) by clipping the waveform that you obtained in (d). Draw a diode clipping circuit suitable for this purpose.

4.(a) Write down five methods of converting an analogue signal to a digital signal. Arrange them in an order according to their conversion time.

(b) Following is a single slope integration analogue to digital converter (ADC) circuit. What are the two types of op-amp circuits used in this ADC?



(c) State the two rules of ideal op-amp technique and derive expressions for the output voltage of those two circuits.

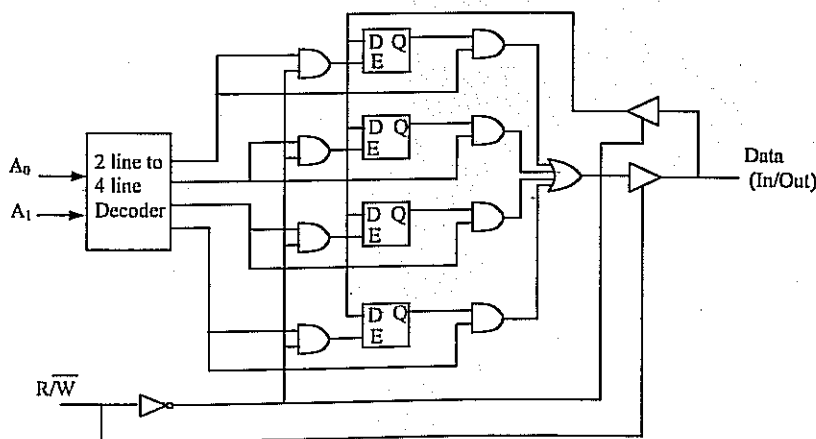
(d) Calculate the time taken by the above ADC to convert an analogue voltage of 4.5 mV, if $R = 10 \text{ k}\Omega$ and $C = 220 \mu\text{F}$.

(e) What are the drawbacks in this circuit? Explain how you would improve this ADC by redrawing this circuit with necessary modifications.

5.(a) What is the basic memory cell that used to store one bit in memory organization?

(b) What is meant by RAM and ROM of a computer system? List the different types of RAMs and ROMs available.

(c) Following is a 4 x 1 bit RAM memory. Briefly explain how you write and read each of the memory cells.



- (d) Draw timing diagram for writing and reading the memory cells of the above circuit for the R/\overline{W} signal.
- (e) Draw the memory map indicating how the word "OPEN UNIVERSITY" is stored in a 2716 EPROM in ASCII codes starting from the address 00000000000. The ASCII codes of the letters in hexadecimals are O-F4, P-05, E-54, N-E4, U-55, V-65, R-25, S-35, I-94, T-45, Y-95.
6. (a) Name the register set in a typical microprocessor.
- (b) What is meant by the terms mnemonics, assemblers, assembly language and machine language in computer programming.
- (c) What is the general operation sequence of a microprocessor to perform a task? Explain how the registers in the processor help in this sequence.
- (d) Write a programme in assembly language to add two numbers a and b .
- (e) Convert this assembly language programme into machine language and draw the memory allocation of the programme when stored in an external memory beginning from address 10_h . Use the following op codes for the mnemonics in the assembly language programme in the conversion.

01 - MOV A, n	02 - MOV B, n
03 - DEC A	04 - DEC B
06 - CMP B, n	07 - ADD A, B
09 - JG m	0B - NOP