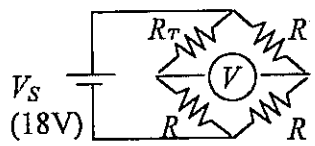
The Open University of Sri Lanka
B.Sc. Degree Programme- Level 05
Final Examination 2008
PHU 3150/PHE 5150- Data Acquisition and Signal Processing

Duration: Two and Half (2 ½) Hours

Date: 24.01.2009 **Time: 09.30 a.m. – 12.00 p.m.**

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

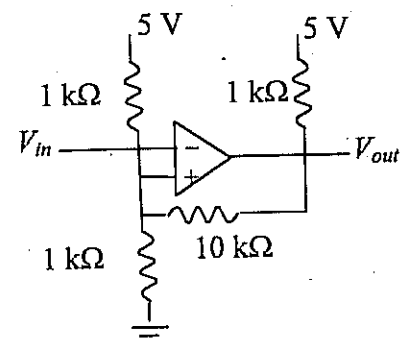
1. (a) What are the tasks of transducers in data acquisition systems?
   (b) In the classification of transducers, how do you define an input transducer, an output transducer, an active transducer and a passive transducer? Give one example for each category.
   (c) Write down four temperature sensors and state where they can be applied.
   (d) Which of the above temperature sensors can replace R_T in the following bridge circuit? Also show that $V = \left(\frac{R}{R+R_T} - \frac{1}{2}\right) V_S$ for the given circuit.



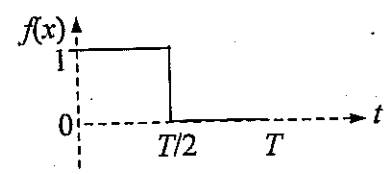
   (e) If the range of the voltmeter is 6 V and the above circuit is capable of measuring from –200 °C to 1000 °C, calculate the value of R_T at 0 °C and 1000 °C.

2. (a) Name two radiation detectors that emit light when charged particles travel through them.
   (b) Name an optical sensor that may be used to detect the emitted light from the above radiation detectors.
   (c) Show that the angle of emission, θ of Cerenkov radiation is $\cos^{-1}(c/vn)$ for a particle entering a medium of refractive index n with velocity v. Here, c is the speed of light in vacuum.
   (d) Calculate the Cerenkov angle of emission of an electron traveling with velocity $0.99999c$ in water given that the refractive index of water is 1.33.
   (e) If the momentum of a relativistic particle is given by $p = \frac{mv}{\sqrt{1-(v^2/c^2)}}$, where m is the rest mass and v is the velocity of the particle, what minimum momentum is needed for an electron to emit Cerenkov radiation? Take the rest mass of electron as 0.5 MeV in your calculations.

3. (a) Write down the two golden rules of operational amplifiers that can be derived from the ideal op amp technique?
   (b) Explain why negative feedback is not used in comparator circuits constructed with op-amps.
   (c) What are the benefits of using IC's optimized as comparators than op-amps as comparators?
   (d) Explain the difference between a comparator and a Schmidt trigger.
   (e) Calculate the threshold voltages of the following Schmidt trigger which has an open collector output.

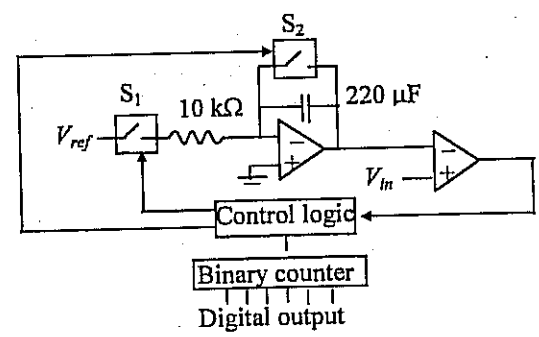


4. (a) Why does spectrum analysis is useful in signal processing stages of data acquisition systems?
   (b) Write down the theory used in spectrum analysis.
   (c) Use the theory given in part (b) to find the spectrum of the following square waveform whose period is T.



   (d) Hence draw the power spectrum of the above signal.
   (e) Name the circuit you need at the signal processing stage to cut off high frequencies of the above spectrum? Sketch a labeled diagram of such a circuit.

5. (a) Write down the methods used for converting an analogue signal to a digital signal. Arrange those methods in the ascending order of the conversion speed.



(b) The above figure shows an ADC based on the single integration method. Explain briefly how the conversion is done in this circuit.

(c) Show that $V_{int} = \frac{V_{ref}\, t}{RC}$ for this ADC.

(d) Hence calculate the time taken by the above ADC to convert an analogue voltage of 3.5 mV.

(e) What are the drawbacks of this circuit? Show how you would improve the circuit by redrawing it with necessary modifications.

6. (a) What are the basic components of a microprocessor?

(b) Write down the sequence of operation of a microprocessor that needs to be followed for executing a programme written into the memory.

(c) Following is a programme written in assembly language. Explain the purpose of writing this programme and write down the operation done at each line of this programme when executed.

```
MOV A, 00
MOV B, 03
ADD A, B
DEC B
CMP B, 00
JG 14
NOP
```

(d) 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. Use the following op codes for the mnemonics of assembly language 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

(e) Tabulate the contents of the registers of the microprocessor after the execution of each instruction of the above programme. (Assume that A, B and Flag registers have the values FF, EF and A0 at the beginning, which were left out from a previous programme)