UNIVERSITY OF LONDON
IMPERIAL COLLEGE OF SCIENCE, TECHNOLOGY AND MEDICINE

EXAMINATIONS 2000

BEng Honours Degree in Computing Part III
MEng Honours Degrees in Computing Part IV
for Internal Students of the Imperial College of Science, Technology and Medicine

This paper is also taken for the relevant examinations for the
Associateship of the City and Guilds of London Institute

PAPER C334

MICROCONTROLLERS AND COMPUTER INTERFACING

Tuesday 2 May 2000, 14:00
Duration: 120 minutes

Answer THREE questions

Paper contains 4 questions

1 a   Real world systems of microprocessors, transducers and actuators fall into three main groups; Data Gathering, Stimulators and On-Line.

   i)   Give a brief description of each class of system.

   ii) On-Line control systems can be further divided depending on the mix of analog and digital sub-systems. Give a description and example of such sub-classifications.

   b   With particular emphasis on sampling, explain why there are different degrees of "Real Time" response.

   c   i)   Compute the minimum aperture time required to accurately sample a 1KHz signal into an 8 bit digital value.

   ii) Compute the minimum sample time for a 1KHz signal that avoids the possible construction of an alias signal.

   iii) Explain the difference between the two values obtained in [c i)] and [c ii)] and the consequence for low-cost analog-to-digital conversion sub-systems.

The three parts carry, respectively, 35%, 20%, 45% of the marks.

2 a   i)   Input transducers are subject to a variety of distortions and errors. Choose four types of such problems and describe their effect on the output of the transducer.

   ii) For each of your four types of problem describe what analog or digital techniques are available to reduce or remove their effect.

   b   A simple infra-red transmitter and detector pair can produce a low signal when a reflection is detected and a high signal when no reflection is detected. The intensity of the reflected light must exceed a certain threshold.

   i)   What steps can be taken to ensure that the detector is immune to ambient light?

   ii) How can such a device be used to measure distance rather than simply the presence or absence of a reflection?

   iii) Why does the signal go low (rather than go high) when the reflection is detected?

   c   i)   What is the definition of the Current Transfer Ratio (CTR) in Optical Isolation Systems?

   ii) How are CTRs over 400% and above achieved?

The three parts carry, respectively, 35%, 45% and 20% of the marks.

3 a   An addressing scheme has to be chosen when interface chips (A/D converters, parallel I/O, counter/timers etc.) are used in microprocessor systems. Such address decoding schemes can be Full or Incomplete, and Incomplete systems can be Degenerate or Reduced.

   i)   Fully explain these terms (3 definitions required) and outline the advantages and disadvantages of each when connecting typical interface chips.

   ii) You are required to interface a single device that has only 4 registers to a microprocessor. The microprocessor has a 16-bit address bus and all data transfers are 8-bit bytes. Design an addressing scheme for this environment that requires the minimum of interface support logic.

   b   Not all processors provide for multiple levels of interrupts. Some of the Intel microcontrollers for example have only one maskable interrupt line (it's true that they also have a non-maskable interrupt, but that is often reserved for emergency use). However, we wish to connect a number of interface devices all of which have the potential to interrupt the processor. Assuming that you have chosen one of the addressing schemes outlined in part [a] to provide access to their individual registers, how would you design the physical *and* logical interrupt structure? What additional support hardware would you need?

The two parts carry, respectively, 40% and 60% of the marks.

4 a   Three common types of motors that are used in control systems are Continuous (Universal), Stepper and Servo motors. By briefly describing the operation of each type of motor explain

   i)   why universal (DC or AC) motors are not appropriate for precise positioning of actuators

   ii) why stepper motors are not appropriate for battery powered systems

   iii) why Servo motors are not appropriate for driving wheels

   b   What environmental factors will effect the speed of a motor and what internal components of a DC motor will effect its speed?

   c   A Proportional Feedback control loop is an effective way of ensuring that a motor runs at a constant speed.

   i)   There are two variables in such a feedback loop that need to be adjusted to suit a particular environment. What are these two variables and what would be the effect of too high or too low a value of each?

   ii) Extend the structure of the feed back control loop to allow for keeping two motors in step (providing straight line control)?

The three parts carry, respectively, 40%, 20%, 40% of the marks.