

UNIVERSITY OF LONDON
IMPERIAL COLLEGE OF SCIENCE, TECHNOLOGY AND MEDICINE

EXAMINATIONS 1996

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

*This paper is also taken for the relevant examinations for the
Diploma of Membership of Imperial College
Associateship of the City and Guilds of London Institute*

PAPER 3.34

COMPUTER INTERFACING AND MICROPROCESSORS

Friday, May 3rd 1996, 2.00 - 4.00

Answer THREE questions

For admin. only: paper contains
5 questions
2 pages (excluding cover page)

- 1 A voice recording and playback machine is proposed which can record and playback a minute of speech. The system will be based around a RISC microprocessor that can execute five million instructions per second. The processor has 1 kbyte of on-chip RAM and 2 kbytes of on-chip ROM. It has six general purpose memory-mapped digital input-output pins and one analogue output pin driven from an on-chip D-A converter.

The system records whilst a record button is held down and stops recording as soon as it is released. The system plays back whilst a play button is held down and stops playing as soon as it is released.

- a Using a clearly labelled block diagram show the minimum amount of hardware required for the system assuming that the processor will assist with A-D conversion.
- b Using a clearly labelled flowchart and/or pseudo code outline the program that should be executed, including the code for the analogue to digital conversion and that to set up the input-output pins and read the buttons.
- c Clearly stating your assumptions, estimate what accuracy would be achievable with this system if no sample and hold were used.

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

- 2a Briefly describe the main features of the internal structure of a counter-timer integrated circuit. What can this chip do and how does it do it ?
- b Write a pseudo-code program that uses a counter-timer chip as the basis of a frequency counter for frequencies in the range 20Hz to 9999Hz that are applied to its external clock input.

Each pseudo-code instruction should correspond to a few assembly language instructions and you may assume a library routine is available to write the value in a register to a four-digit 7-segment LED display. The display should be updated every second.

- c Briefly explain how you would need to change your design if the display had to be updated one hundred times per second and be accurate to $\pm 10\%$.

The three parts carry, respectively, 60%, 20%, 20%, of the marks.

- 3a Using clearly labelled diagrams, explain how a stochastic D-A converter works.
- b Write a pseudo-code program that reads a waveform from memory and uses one bit of the parallel output port on a 100 MHz Pentium PC to present a stochastic D-A pulse train to an integrator, amplifier and loudspeaker connected to the output port.

Clearly stating your assumptions and showing your calculations, estimate whether or not the Pentium could reproduce intelligible speech using your program.

The two parts carry equal marks.

- 4 i) Using a clearly labelled circuit diagram show how a 0.5A inductive load (a bifilar stepper motor winding) can be driven through a transistor connected to a TTL-compatible output port which can source 50mA.

You should include circuitry to ensure the load is switched on and off rapidly and ensure that sufficient components are present to protect the circuitry from transient voltages produced by the inductor during switching.

- ii) Carefully explain the function of each component you use and estimate the value of any resistors. Assume that a 10V supply is available to drive the coil and the coil's resistance is 10 Ohms.

- iii) Estimate the power rating required for the resistor that gets hottest.

Estimate the power dissipated in the transistor if the coil is part of a four-pole stepper motor in continuous rotation in a single direction.

- iv) If a 55°C/W heat sink was used on the transistor and room temperature was 20°C how hot would the heat sink get ?

What effect would not using the heat sink have on the life of the transistor ?

- v) Explain what additional circuitry would be needed to make the stepper motor accelerate as quickly as possible without missing any steps.

The five parts carry, respectively, 30%, 20%, 30%, 10%, 10% of the marks.

- 5a Referring to a clearly labelled block diagram and clearly labelled waveforms, describe the design and operation of a delta-sigma analogue to digital converter.
- b What limits the accuracy and speed of this converter ?
- c Explain what non-monotonicity and differential non-linearity are and outline any sources of them in this converter, giving reasons.
- d Give an example of an application for which this converter is ideally suited, explaining why this converter is uniquely matched for the chosen application.

The four parts carry, respectively, 50%, 20%, 20%, 10%, of the marks.

End of paper