

THE UNIVERSITY OF AUCKLAND

EXAMINATION FOR MSc ETC 1998

COMPUTER SCIENCE

Robotics and Real-time Control

(Time allowed : TWO hours)

NOTE : Answer any ten questions.

PART A.

QUESTION 1.

Explain what is meant by an open-loop control system, and note its advantages and disadvantages. Explain how an adaptive open-loop control system would work, and identify any circumstances in which such a system could be effective even if a closed-loop controller could not be used.

QUESTION 2.

Explain the nature of ladder-logic diagrams as used with PLCs (Programmable Logic Controllers). Stick to simple logic; ignore variable signals and complicated functions.

A system has two spring-loaded buttons, one labelled "on" and one "off". Each makes a contact while it is depressed. Show a simple ladder diagram (which may only have one rung) with which signals from these buttons can switch a power source on or switch it off in the obvious way, ensuring that if both buttons are pressed at the same time the power will be turned off, and explain how it works. (Do not worry about standard notation - just make sure that it's comprehensible.)

QUESTION 3.

Briefly describe how CNC (computer numerical control) machine tools evolved from manually operated machine tools, and explain why they are economical to use.

State the function of a part-programming language (such as APT). What must such a language describe ? What special sorts of data type would you expect to be provided ?

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QUESTION 4.

Explain how highly automated plant can lead to dangerous situations in the three cases listed below. Describe any remedies of which you are aware.

- (a) When the operator distrusts the plant;
- (b) When the operator is accustomed to the plant and is satisfied that it works;
- (c) When the operator becomes overconfident of the plant's competence.

QUESTION 5.

Describe in outline how the design of a new product is converted into a programme for controlling its manufacture by a manufacturing system comprising several machines.

QUESTION 6.

What is a cyclic executive system ? Describe how it works, and list its advantages and disadvantages, with a brief explanation of each.

QUESTION 7.

Time is a characteristic feature of real-time programming. What language constructs connected with time would you expect to find in a programming language designed for use with real-time systems ?

In both cases below the first line gives a declaration; explain in outline what the compiler must do to deal with the two when instructions.

From ILIAD :

```
counter integer initial( 0 ),
.....
when ( counter = 60 ) <instruction>
```

From PEARL :

```
specify alarm interrupt
.....
when alarm <instruction>;
```

QUESTION 8.

Distinguish between errors, faults, and failures. Explain in outline how shallow and deep intelligence are implemented in intelligent failure management systems. Point out differences between the sorts of failure which they can be expected to deal with, and comment on their respective reliabilities.

QUESTION 9.

State two common definitions of a robot, and give an example of a machine which conforms to one definition but not to the other. State your own preferred definition of a robot, which might or might not be one of those you have already described, and explain why you believe it to be superior.

QUESTION 10.

Define the notions of link and joint in robot geometry. Distinguish between joint coordinates and actuator coordinates, and explain how they might be different. Show how a robot configuration can be described in terms of Denavit-Hartenberg parameters. Sketch, and name, the types of joint which correspond to the two free variables in the Denavit-Hartenberg scheme.

QUESTION 11.

Describe how and why an autonomous robot's requirement for sensory information differs from that of simpler machines, and show how a continuously maintained world view satisfies the requirements.

Explain the nature and necessity of compliance. Present a simple example, and show how the behaviour depends on sensory information.

QUESTION 12.

Explain what is meant by on-line and off-line robot programming, and list advantages and disadvantages of both.

Identify several (at least three) different levels of sophistication in robot programming languages, and explain the differences between them.

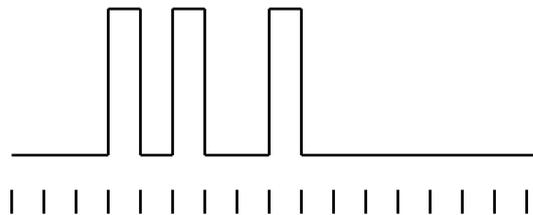
PART B.

QUESTION 13.

Explain how an interface adapter chip is "memory mapped" to a computer's address space, and explain the advantages of using such an interface device.

QUESTION 14.

The diagram below shows an oscilloscope trace of a single character sent by a computer along a standard serial line as a 7-bit character with even parity and two stop bits, together with a time base. Time increases from left to right.



- (a) Redraw the diagram in your answer book, and mark the start bit, character, parity bit, and stop bits.
- (b) Write the character as a binary number.
- (c) How might a receiver interpret the same signal if it assumes that the bit rate is twice as great as it is in fact ? Explain your answer. (Detailed understanding of the RS232 standard is not expected; any satisfactorily explained interpretation is acceptable.)

QUESTION 15.

Describe the components of a simple analogue computer, and explain why the output of an adder is inverted. Present a diagram to show how a suitable set of components can be connected to simulate the behaviour of a system defined by the equations

$$\begin{aligned} dx/dt + Ay &= 0 \\ dy/dt + Bx &= 0 \end{aligned}$$

given initial values for x and y .

QUESTION 16.

A lighting controller for a room is driven by interrupts from a clock, a movement detector, and the door. Door interrupts are received whenever the door is opened or closed. The light is to be switched on whenever the door is open, or whenever there has been an interrupt from the movement detector within the last two clock interrupts. Draw a state diagram for the controller.
