THE UNIVERSITY OF AUCKLAND

EXAMINATION FOR MSc ETC 1997

COMPUTER SCIENCE

Robotics and Real-time Control

(Time allowed : TWO hours)

INSTRUCTIONS : Answer any ten questions.

PART A.

QUESTION 1.

Briefly describe PID (three-term) controllers and PLCs (Programmable Logic Controllers), pointing out in each case the type of control problem which the device is designed to solve.

QUESTION 2.

Describe a closed-loop control system. Assuming that the behaviour of all components of the system is precisely known, and that a computer is used as the controller, what sort of analysis is necessary to determine the task which its programme must accomplish ? How is this task made more difficult by (a) time delays and (b) sampled data ?

QUESTION 3.

What is a flexible manufacturing system (FMS) ? Identify the components of a FMS, and show how it differs from an assembly line and from a job shop, commenting on the differences between the components of the three manufacturing techniques.

QUESTION 4.

Explain how the nature of people's interaction with machines has altered with increasing automation. Give two examples of difficulties caused by this change, with brief explanations of their causes and possible remedies.

QUESTION 5.

Compare the task scheduling problems faced by general-purpose operating systems and by real-time systems, and show how differences between the two sorts of system can be exploited to develop a class of real-time scheduling techniques.

QUESTION 6.

Describe in outline a systematic method for producing a specification document for a system from a consideration of the required system functions. Explain the importance of this design step.

QUESTION 7.

List the features which you would hope to find in a programming language for real-time control systems, and which are not provided in conventional procedural languages. Comment on any difficulties you perceive in providing such facilities in a high-level language.

QUESTION 8.

Identify the most urgent primary task of a real-time control system when a failure is detected, and describe it in terms of the system's states. Use the description to show what must be done to accomplish the task, and explain why it is difficult.

QUESTION 9.

Define a robot, and explain how robots differ from other machines from the point of view of computer control.

QUESTION 10.

Describe the forward and inverse kinematics problems in robotic systems. Define the reachable and dextrous workspaces of the robot, and show how they are related to the existence of solutions to the inverse kinematic problem.

QUESTION 11.

List some advantages of vision as a sensor for robotics. Describe some problems of machine vision with ambient light, and give an example to show how the use of structured light can simplify a problem.

QUESTION 12.

Present in outline an argument to the effect that it is impossible manually to programme a robot for realistic behaviour in the real world. Briefly describe the "subsumption" architecture, and say, with reasons, whether you believe it to be an improvement on conventional programming methods.

PART B.

QUESTION 13.

Describe the function of an interface adapter chip, such as the VIA. Explain in outline how it is used and how it is attached to the processor.

QUESTION 14.

Explain why accurate timing is essential for reliable communication between two devices communicating through an RS-232 serial communications line. Describe one method by which such a device can determine the parameters used by a communicating partner, and make clear what conditions must be satisfied if the method is to work reliably. (Assume that the device must communicate through a conventional serial interface adapter; direct access to the line signals is not possible.)

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

$dx/dt + Ay = 0$
$dy/dt + Bx = 0$

given initial values for x and y.

QUESTION 16.

Describe the operation of a simple stepper motor, explain why stepper motors are useful, and show how a stepper motor's input signals must be controlled to give continuing motion in one direction.