Robotics and Automation

DATE:	14th June 1993
TIME:	9.30 am - 12.30 pm
DURATION:	3 Hours

1, 4, 5, 6

EXAMINER: M D Butler   **Ext No:** 5325

Instructions to Candidates:

This paper contains seven questions.
Candidates must answer <u>four</u> questions.
All questions carry equal marks.

Students Will Require:

1. (a) When investigating manufacturing areas with a view to implementing a robotic system it is said that one should look first at areas which come under one of the 4 D's. What are these 4 D's and why are they most likely to attract such interest?

(5 marks)

(b) In order to proceed with a project to robotise a particular production process the production engineer must be satisfied that the system is 'Technically Practical' and 'Economically Viable'.

(i) List 5 features of a robot system that MUST be considered when appraising the feasibility of the project. Give reasons for your selection.

(10 marks)

(ii) As with any investment in technology the initial capital costs are large. It is, however, the balance between operating costs and savings which determine the payback time and the suitability of the project.

Describe 5 areas which you consider to have the greatest impact in terms of operating costs and savings.

(10 marks)

2. (a) Provide an outline specification for a Gripper to be used to load and unload parts from a cnc turning centre. The machine is always supplied with raw material, aluminium or steel, with diameters from 10 to 30 mm. The finished component can vary in shape, although there is always a 20 mm length of plain shaft, and they can be solid or bored with wall thicknesses as low as 0.75mm.

(10 marks)

(b) A robot with a double sided gripper is used to load and unload boards from a cnc PCB drilling table. The PCB's can only be load/unload from the machine with the table in one corner position, the fixture to hold the PCB for drilling is automatic.

(i) List out the interlocks that you consider necessary for the safe and efficient operation of this system. Indicate the type of sensor you would use.

(5 marks)

(ii) Describe the sequence of operations that would make up the control program for the load/unload cycle. Indicate the state of the interlocks at each stage of the process.

(10 marks)

3. (a) (i) Draw, and clearly label, a block diagram for a position control system for one joint of a robotic arm using PID control.

(5 marks)

(ii) Describe, with the aid of sketches, the purposes of the Integral and Derivative elements in this form of control system. Clearly outline why these terms are necessary in a robot joint position controller ?

(10 marks)

(b) Control system designers are looking to use Adaptive Control techniques to overcome some of the problems associated with robotic arm control. Outline what is meant by 'Adaptive Control' and describe ONE method which could be adopted for use in a robot control system.

(10 marks)

4. (a) Describe, with the aid of diagrams, the problems associated with 'peg-in-hole' assembly tasks.

(5 marks)

(b) Remote Centre Compliance (RCC) devices can be used to overcome many of the problems associated with 'peg-in-hole' assembly. Describe how RCC devices work. What are the limitations of such devices?

(10 marks)

(c) Outline a design for an active device which could be used in place of the RCC and one which would be more flexible and overcome the drawbacks of the RCC. Describe how the system would operate and indicate the problems associated with such devices.

(10 marks)

5. (a) What is a Programmable Logic Controller (PLC) ?

Your answer should include :

- a description, with diagrams, of the basic configuration of a PLC;

- an outline of the advantages of a PLC over, say, the use of a PC or similar computer system;

- a description of the basic operation of a PLC including an illustration of the program cycle;

- an explanation of ladder diagrams and why this method continues to be the most widely used form for programming PLCs.

(20 marks)

(b) PLCs are often used to control individual machines and these can be linked in turn, along with several others, to a more powerful PLC to make up a manufacturing cell or system. Illustrate what such a control system may look like and outline briefly how it could be integrated into the computer hierarchy of a manufacturing company.

(5 marks)

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6. (a) Compare and contrast the use of lead-through and drive-through methods of programming a robot when used in the following applications:

(i) Material Transfer
(ii) Application of Adhesive   (10 marks)

(b) (i) Outline the primary components which would make up a Graphical Robotic Application Simulation Package.
(10 marks)

(ii) Provide summary of the advantages and disadvantages to be gained as a result of implementing an off-line programming system.

(5 marks)

7. (a) Describe how data can be transmitted between computer based devices using serial communication. Include a comparison of the advantages and disadvantages of using asynchronous and synchronous forms of transmission.

(7 marks)

(b) Control of the flow of data between machines is very important, particularly when they have markedly different operating speeds. Outline how flow control can be achieved using:-

(i) a hard-wired system;
(ii) a software system.   (6 marks)

(c) In a manufacturing system data has to be transmitted through potentially very noisy electrical environments. Flow control and parity checks are not, in themselves, sufficient to ensure that the data arrives uncorrupted, either at the machine or the computer linked to it. Describe a protocol which could be employed to ensure a high degree of reliability in the transfer of data in such an environment. Include a flow chart showing the flow control programs for the two devices and how they interact.

(12 marks)