

# DAVID GREAVES COLLECTION

CSD1/4

DIPLOMA IN COMPUTER SCIENCE

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Saturday 4 June 1977. 9 to 12

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## PAPER 4

*Answer five questions including at least one from  
Section A and at least three from Section B.*

### SECTION A

1. In Algol W the expression S(P) could be a reference to an element of an array, a reference to a field within a record, or a procedure call depending on the declarations of the variables involved. Other languages sometimes distinguish these three cases syntactically. Discuss the relative merits of these two approaches.

2. Describe the routing algorithm used in the ARPAnet.

Discuss the problem of avoiding congestion in a computer network in relation to *routing, virtual calls, and flow control.*

3. In a general-purpose filing system a directory must contain some information about where each file is stored. Describe two methods of recording and checking the physical allocation of disc space to files, giving the advantages and disadvantages of each.

4. Describe the purpose of the condition code and program mask fields in the second word of the PSW of an IBM/370. Explain carefully the action of the BCR (branch-on-condition, register) instruction. The instructions SR, CR and CLR (subtract, compare and compare logical) all set the condition code according to the contents of the two operand registers. Describe the differences between the ways in which the condition code is set.

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SECTION B

5. The quantities  $H$  and  $S$  are defined by

$$S^2 = x_{r+1}^2 + \dots + x_r^2, \quad H = S^2 + |x_{r+1}|S$$

where  $(x_1, x_2, \dots, x_n)$  are the components of a vector  $\underline{x}$ . The vector  $\underline{u}$  is defined by

$$\underline{u} = (0, 0, \dots, x_{r+1} \pm S, x_{r+2}, \dots, x_n)$$

If  $P = I - (\underline{u} \underline{u}')/H$  show that the matrix  $P$  is symmetric and orthogonal, and that the vector  $P\underline{x}$  has zero components in the positions  $(r+2), (r+3), \dots, n$ .

Describe how these results may be used to obtain a sequence of  $(n-2)$  similarity transformations which reduce the  $(n \times n)$  symmetric matrix  $A$  to symmetric tridiagonal form.

Explain what happens if the same sequence of transformations is applied to a real unsymmetric matrix.

6. Describe the characteristics and mode of action of disc storage devices. What factors have led to their large scale use?

7. Either

LISP claims to be a 'general' specialized language. Which, if any, of its particular features would be useful in each of the following applications:

- (a) string processing of the SNOBOL type,
- (b) discrete simulation in the SIMULA style?

Or

Describe a small set of primitive operations that may be thought of as forming a basis of LISP. Sketch a proof that LISP is computationally universal by showing how these primitives make it possible to simulate a Turing machine.

8. Obtain a second-order iteration to solve the equation

$$\tan(x) = x - \frac{1}{2}$$

Show how you would choose a starting value and an end criterion to obtain the smallest positive solution to the maximal precision of your computer.

9. Give human factor arguments relevant to the design of iterative graphics systems. Discuss visualization aids and methods for providing rapid response to certain actions.

10. Describe a way of choosing an order for solving linear equations so as to preserve sparseness in their coefficient matrix. What results does your method give if handed a tri-diagonal matrix? Estimate (crudely) the time it takes as a function of the size of the tri-diagonal matrix.

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11. Describe three signalling methods suitable for serial data transmission by wire. The ASCII code includes control characters, many of which are concerned with the control of such transmissions. Show how these characters may be used in the transfer of several fixed-length blocks of data in synchronous mode.

12. Explain the difference between *editing* and *selection*.

Produce an algorithm to give the approximate solution to the equations

$$x + ex^2y = 1$$

$$y + 3x(1+ey) = 5$$

for small  $e$ , and write an algebra program for this algorithm. What part does editing or selection take in your solution?

13. The following conditions define events consisting of strings in the alphabet  $(0,1)$ :

- (a)  $s \in E_1$  if and only if  $s$  contains more 0's than 1's;
- (b)  $s \in E_2$  if and only if 0 and 1 alternate in  $s$ ;
- (c)  $s \in E_3$  if and only if  $s$  contains the same number of 0's and 1's;
- (d)  $s \in E_4$  if and only if  $s$  does not contain the substring '1101'.

Which of the above events are regular? Where possible design a finite state automaton that accepts the event  $E_i$ .

14. Among the principles of the Younger Committee concerning data protection are the following:

- (a) Information may be held only for the specific purpose for which it was collected.
- (b) Any subject has the right to be told about the information concerning him.

It is assumed that within a short time data protection legislation will be enacted which enshrines in law the above principles. Discuss the technical and political impact of the legislation in the following situations:

- (i) a batch payroll system in a large multi-national company;
- (ii) an on-line system for recording details of new policies in a life-assurance company;
- (iii) a hospital system for the storage of patients' medical records.