King’s College London

UNIVERSITY OF LONDON

This paper is part of an examination of the College counting towards the award of a degree. Examinations are governed by the College Regulations under the Authority of the Academic Board.

M.Sci. EXAMINATION

CP/4730 The C programming language for physicists

SUMMER 1998

Time allowed: **TWO HOURS**

Candidates must answer any TWO questions. No credit will be given for attempting a further question.

The approximate mark for each part of a question is indicated in square brackets.

Good answers to questions will include plans and explanations in addition to sections of C code.

TURN OVER WHEN INSTRUCTED

Answer TWO questions

1) Write a short program in C, which reads in an integer and finds all of its prime factors, including repeated factors.

[20 marks]

2) The diffusion equation in one dimension is given by:

$$D\frac{\partial^2 C}{\partial x^2} = \frac{\partial C}{\partial t}$$

where D is the diffusion constant of the material and C is the concentration of the diffusing quantity.

Write a short C program which reads an array from a file `initial.d`, which contains the concentration $C(x,0)$ at time zero, at `n` equally and closely spaced points along the x-axis, and calculates the concentration, $C(x,t)$, at later times using the finite difference expressions for the differentials in the diffusion equation. Set the values at the ends of the x-axis to be constant in time.

[20 marks]

[For a discrete time step δt: $\frac{\partial C}{\partial t} \approx \frac{C(x,t+\delta t) - C(x,t)}{\delta t}$, but for the spatial differentials, use the symmetrical version:

$$\frac{\partial^2 C}{\partial x^2} \approx \frac{C(x+\delta x,t) + C(x-\delta x,t) - 2C(x,t)}{\delta x^2}$$

where δx is the distance between the points at which C is defined.]

3) Write a function in C which calculates the function $\text{sinc}(x)=\frac{\sin x}{x}$ to 5 significant figures, using the series for $\sin x$:

$$\sin x = x - \frac{x^3}{3!} + \frac{x^5}{5!} - \frac{x^7}{7!}\cdots$$

You should use some sort of convergence criterion, and be especially careful when $|x|$ is large or very near zero.

[20 marks]

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