

## 1997 Paper 4 Question 9

### Numerical Analysis I

Explain the terms *unit round off* and *machine epsilon* (*macheps*). Why is *machine epsilon* used in preference to *unit round off* for practical purposes? [4 marks]

In the IEEE binary floating-point Standard (*IEEE 754*), what *exponent* and *significand* are used in representing each of the numbers 0, 1 and 2 in single precision? How are the exponent and significand stored in each case? [6 marks]

Show the 32 bits that represent  $(1 + \text{macheps})$ . What is the *exact* value of *macheps* in this case? [4 marks]

What are the two sources of error in the formula

$$f'(x) \simeq \frac{f(x+h) - f(x)}{h}$$

and how does each type of error behave as  $h$  increases? [4 marks]

Suggest a suitable value of  $h$  if using this formula with IEEE single precision when  $f(x) = O(1)$ . [2 marks]