

2006 Paper 10 Question 8

Numerical Analysis I

- (a) An IEEE Single Precision number is stored in 32 bits, of which 8 bits are reserved for the exponent. Explain the terms *normalised number* and *hidden bit*. How many bits are used to store the *significand*, and what is the *precision*? Show by means of a diagram how the bits are arranged in storage. [4 marks]
- (b) How is the value of the exponent stored? What are the stored values of the exponents e_{min} and e_{max} ? [3 marks]
- (c) Which values are represented by the following bit patterns? [Show signs where appropriate.]
- (i) 00000000 00000000 00000000 00000000
- (ii) 11111111 11111111 11111111 11111111
- (iii) 00111111 10000000 00000000 00000000
- (iv) 11000000 00000000 00000000 00000000
- (v) 00000000 00000000 00000000 00000001
- (vi) 01111111 10000000 00000000 00000000 [6 marks]
- (d) Define *machine epsilon* ε_m . Estimate its value in IEEE Single Precision. [2 marks]
- (e) 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? Suggest a suitable value of h to use with this formula for IEEE Single Precision when $f(x) = O(1)$. [5 marks]