

Instructions for preparing the solution script:

- Write your name, ID#, and Section number clearly in the very front page.
- Write all answers sequentially.
- Start answering a question (not the part of the question) from the top of a new page.
- Write legibly and in orderly fashion maintaining all mathematical norms and rules. Prepare a single solution file.
- Start working right away. There is no late submission form. If you miss the deadline, you need to use the make-up assignment to cover up the marks.

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1. In the classes, we discussed three forms of floating number representations as shown below,

$$\text{Lecture Note Form} : F = \pm(0.d_1d_2d_3 \cdots d_m)_\beta \beta^e, \quad (1)$$

$$\text{Normalized Form} : F = \pm(1.d_1d_2d_3 \cdots d_m)_\beta \beta^e, \quad (2)$$

$$\text{Denormalized Form} : F = \pm(0.1d_1d_2d_3 \cdots d_m)_\beta \beta^e, \quad (3)$$

where  $d_i, \beta, e \in \mathbb{Z}$ ,  $0 \leq d_i \leq \beta - 1$  and  $e_{\min} \leq e \leq e_{\max}$ . Now, let's take,  $\beta = 2$ ,  $m = 4$  and  $-3 \leq e \leq 6$ . Based on these, answer the following:

- (4 marks) What are the maximum numbers that can be stored in the system by the three forms defined above?
  - (4 marks) What are the non-negative minimum numbers that can be stored in the system by the three forms defined above?
2. Let  $\beta = 2$ ,  $m = 4$ ,  $e_{\min} = -1$  and  $e_{\max} = 2$ . Answer the following questions:
- (4 marks) Compute the minimum of  $|x|$  for normalized form.
  - (4 marks) Compute the Machine Epsilon value for the denormalized form.
  - (4 marks) Compute the maximum delta value for the form given in Eq.(1).
3. (10 marks) Let  $f(x) = e^x - \sin(x) + x - 1$ . To evaluate  $f(x)$  near zero we need to compare  $f(x)$  to the Taylor expansion of  $f(x)$  at  $x = 0$ . Evaluate the Taylor coefficients,  $a_0, a_1, a_2$ , if we compare  $f(x)$  with degree two polynomial near zero.