Last Name: First name: **Student ID:**

1. Find the fixed points of the following one-dimensional equations. Classify the stability of each fixed points by using linear stability analysis, or a graphical argument if linear analysis fails. Sketch the phase portrait on the real line. Sketch the solution graph $x(t)-t$.

[20] (a) $x' = (x - 1)(\sin x - \cos x)$ (b) $x' = (x^2 - 7x + 6)(6 - x)$
(c) $x' = \tanh x - \beta x, \beta > 0$ (d) $x' = \mu x + x^3 - x^5, \mu > 0$.

[30] 2. Sketch the bifurcation diagram of fixed points x^* vs. r. Indicate the type of the bifurcation.

(a) $x' = x(1-rx+x^2)$ (b) $x' = (x-1)(r-e^{-x})$ (c) $x' = rx - \frac{x}{1+x^2}$ (d) $x' = rx+x^3-x^5$

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[50]