

You must justify your answers to receive full credit.

**You may use any (correct) method on the extremisation problems, regardless of which section the questions come from.**

- 13.2 Q1, 9
  - 13.3 Q6 (You may assume that a shortest distance exists. Hint: minimising the distance function is the same as minimising the distance-squared function, and the algebra is easier if you let the objective function be the distance-squared.)
  - 13.3 Q21 (You may assume that this minimum exists.)
  - to be added later
  - to be added later
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1. Does the function  $f(x, y) = x^2 - 2x + 1 + y^2$  have a maximum value or a minimum value on  $\mathbb{R}^2$ ?
  2. Find the maximum and minimum values of  $f(x, y, z) = 2xy^2 + z$  over the closed region bounded by the paraboloid  $z = 1 - x^2 - y^2$  and the plane  $z = 0$ . (Hint: the region has 3 boundary pieces, compare with the half-ball in p7 of week 11 notes. The 1D boundary piece can be parametrised by  $(x, y, z) = (\cos t, \sin t, 0)$ . I think there are 10 candidate extrema in total.)

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