

## NUMERICAL OPTIMISATION ASSIGNMENT 1

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**EXERCISE 1.** Given the following function

$$f(x, y) = 2x + 4y + x^2 - 2y^2$$

- (a) Visualise the function and its contours.

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- (b) Calculate the contours analytically.

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- (c) Calculate the gradient analytically. Find the stationary points and classify them i.e. are they minima, maxima or something else?

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<https://eduassistpro.github.io/>

**EXERCISE 2.**

- (a) Show that  $A = B^T B$  is symmetric positive semidefinite.  $B \in \mathbb{R}^{n \times n}$ . *Hint: use the Rayleigh quotient representation of the eigenvalues.*

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- (b) Let  $f(x) = x^T A x$  with  $A$  symmetric positive semidefinite matrix  $A \in \mathbb{R}^{n \times n}$ . Show that  $f(x)$  is convex on the domain  $\mathbb{R}^n$ . *Hint: you may want to show the equivalent inequality instead*

$$f(y + \alpha(x - y)) - \alpha f(x) - (1 - \alpha)f(y) \leq 0.$$

*Submit your solutions via Turnitin.*

Remark. The submission to Turnitin should not be longer than 5 pages. Avoid submitting more code than needed (if any) and focus on explaining your results.