## Home Work #1

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### 1 Question 1

$$f_X(x) = \frac{ab}{b^2 + x^2}, \quad b > 0$$

#### 1.1 part a

$$\int_{-\infty}^{+\infty} f(x) dx = 1 \quad \to \quad \int_{-\infty}^{+\infty} \frac{ab}{b^2 + x^2} dx = 1 \to a \arctan(\frac{x}{b}) \Big|_{-\infty}^{+\infty} = 1 \to a\pi = 1 \to a = \frac{1}{\pi}$$
$$f_X(x) = \frac{1}{\pi} \frac{b}{b^2 + x^2}, \quad b > 0$$

#### 1.2 part b

$$E(X) = \mu_X = \int_{-\infty}^{+\infty} x f(x) dx$$

Because xf(x) is an odd function, the result of the integrator between  $\infty$  and  $-\infty$  is zero.

$$\int_{-\infty}^{+\infty} x f(x) \mathrm{d}x = 0 \to \mu_X = 0$$

$$\sigma_X^2 = E((X - \mu)^2) = \int_{-\infty}^{+\infty} (x - \mu)^2 f(x) dx = \int_{-\infty}^{+\infty} x^2 f(x) dx = \left. \frac{b}{\pi} (x - b \arctan(\frac{x}{b})) \right|_{-\infty}^{+\infty} \neq \text{finite}$$

Ali BaniAsad 401209244 CONTENTS

## Contents

L	uestion 1	1
	1 part a	1
	2 part b	1

Ali BaniAsad 401209244 LIST OF FIGURES

# List of Figures

Ali BaniAsad 401209244 LIST OF TABLES

## List of Tables