EP 122 Second mid-term exam 07/05/2014
Answer all questions. Duration 80 minutes.

1	2	3	4	5	6	7		TOT
				xxx	xxx	xxx		

To be completed only by the lecturer

Student Name, Surname	**Student Id No**

EDUCATION TYPE: ☐ **First Education** ☐ **Second Education**

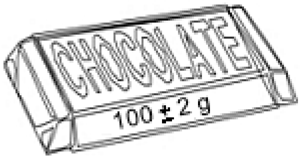
Question 1 [25%]

A local ice cream shop keeps track of how much ice cream they sell versus the temperature on that day. Table shows their data for the last 10 days. Calculate the correlation coefficient of the data and comment on the result.

Temperature	Ice Cream Sales
14 °C	215 ₺
16 °C	325 ₺
15 °C	332 ₺
18 °C	406 ₺
19 °C	412 ₺
25 °C	614 ₺
23 °C	544 ₺
18 °C	421 ₺
22 °C	445 ₺
17 °C	408 ₺

Question 2 [25%]

A machine produces chocolates. Assume that the variation in the weight of the chocolates are normally distributed. The mean weight and standard deviation of the population are given by $\mu = 100$ g and $\sigma = 2$ g respectively. To determine if the machine is adequately calibrated, a sample of $n = 13$ chocolates are chosen at random and the chocolates are weighed. The measured values in grams are:



$$W = \{101, 102, 100, 99, 98, 100, 99, 101, 103, 101, 98, 100, 100\}$$

(a) Write down the median of the sample

(b) Write down the mod of the sample

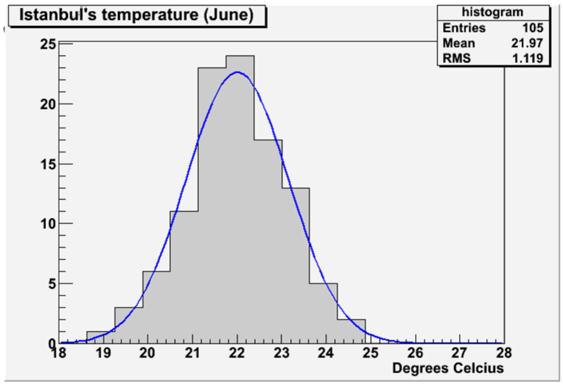
(c) Calculate the sample mean

(d) Calculate the sample standard deviation

(e) Write down the interval that includes the population mean with 95% confidence level and comment on the results.

Question 3 [25%]

In İstanbul, the temperature during June is normally distributed with mean 22.0 ^{o}C and standard deviation 1.2 ^{o}C. Find the probability p that the temperature is between 21.0 ^{o}C and 24.0 ^{o}C.



Question 4 [25%]

A temperature measurement element has an input range of 20 to 120 Celsius. The output of the element (milli-volts) is measured under standard conditions and a second-order polynomial fit to the data yields the following calibration function:

$$O(T) = 1.9 + 0.1\,T + 0.05\,T^{2}$$

(a) Write down the ideal linear response equation

(b) Write down the non-linearity function

$$\bar{x} = \frac{1}{N}\sum_{i=1}^{N} x_i \quad \sigma = \sqrt{\frac{1}{N-1}\sum_{i=1}^{N}(x_i - \bar{x})^2} \qquad \sigma_E = \frac{\sigma}{\sqrt{N}}$$

$$\bar{x} = \frac{\sum_{i=1}^{n} x_i / \sigma_i^2}{\sum_{i=1}^{n} 1/\sigma_i^2} \qquad \bar{\sigma} = \frac{1}{\sqrt{\sum_{i=1}^{n} 1/\sigma_i^2}}$$

$$\sigma_f^2 = \left(\frac{\partial f}{\partial x_1}\right)^2 \sigma_1^2 + \left(\frac{\partial f}{\partial x_2}\right)^2 \sigma_2^2 + \cdots + \left(\frac{\partial f}{\partial x_n}\right)^2 \sigma_n^2$$

$$P(A \cup B) = P(A) + P(B) - P(A \cap B)$$

$$P(B \mid A) = P(A \cap B) / P(A)$$

$$E[X] = \sum_i x_i\, f(x_i) \qquad E[X] = \int_{-\infty}^{+\infty} x\, f(x)dx$$

$$E[X^2] = \sum_i x_i^2\, f(x_i) \qquad E[X^2] = \int_{-\infty}^{+\infty} x^2\, f(x)dx$$

$$\sigma^2 = E[X^2] - (E[X])^2 = \langle X^2 \rangle - \langle X \rangle^2 \qquad RMS = \sqrt{E[X^2]}$$

$$P_{binom} = \binom{n}{k}(p)^k (1-p)^{n-k}$$

$mean : np \qquad std.dev : \sigma = \sqrt{np(1-p)}$

$$P_{poisson} = \frac{e^{-\lambda}\lambda^k}{k!}$$

mean : $\lambda = np$

$std.dev. \sigma = \sqrt{\lambda}$

$$p_{gauss} = \frac{1}{\sigma\sqrt{2\pi}} \exp\left(-\frac{1}{2}\left(\frac{x-\mu}{\sigma}\right)^2\right)$$

$mean : \mu \qquad std.dev : \sigma$

$$\rho = \frac{\overline{xy} - \bar{x}.\bar{y}}{\sigma_x \sigma_y} \qquad \overline{xy} = \frac{1}{n}\sum_{i=1}^{n} x_i y_i \quad \bar{y} = \frac{1}{n}\sum_{i=1}^{n} y_i$$

$$\bar{x} = \frac{1}{n}\sum_{i=1}^{n} x_i \qquad \sigma_x = \sqrt{\frac{1}{n-1}\sum_{i=1}^{n}(x_i - \bar{x})^2}$$

$$\sigma_y = \sqrt{\frac{1}{n-1}\sum_{i=1}^{n}(y_i - \bar{y})^2}$$

Cumulative Distribution Function for Standard Normal Distribution