EP 122 First mid-term exam 26/03/2014
Answer all questions. Duration 100 minutes.

1	2	3	4	5	6	7		TOT

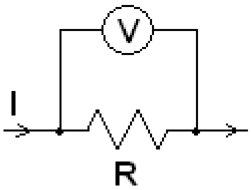
To be completed only by the lecturer

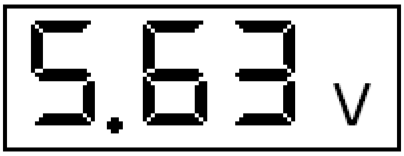
Student Name, Surname	Student Id No

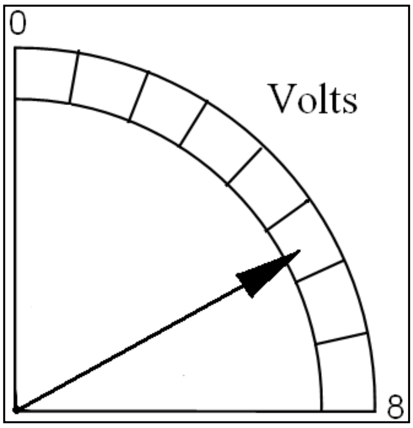
EDUCATION TYPE: ☐ **First Education** ☐ **Second Education**

Question 1 [15%]

Consider a simple circuit below.







The potential difference in volts between two ends of the resistor in the circuit are measured by first a digital voltmeter and then by an analog voltmeter independently. Measurement results are indicated in the figures given right.

(a) Write down the measured values and associated (reading) errors respectively.

Digital value ± reading error: Analog value ± reading error:

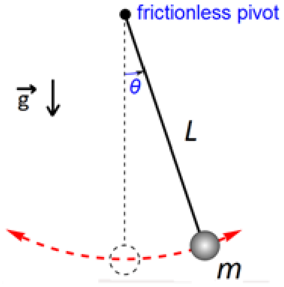
(b) Compute the result of combined measurement of the potential difference in volts.

Question 2 [15%]

Imagine that 25% of the bolts produced by a machine are defective. 5 bolts are selected randomly. What is the probability that more than two of them are defective?

Question 3 [20%]

Consider the data from 10 different measurements for the period T (in seconds) of a simple pendulum.



$$T = \{10.0, 9.9, 10.2, 9.9, 9.8, 10.3, 9.6, 10.0, 10.0, 9.7\}$$

Compute

(a) the mean

(b) the standard deviation

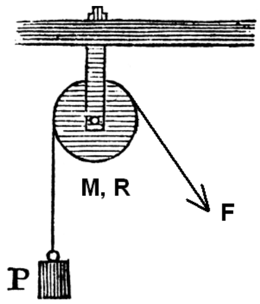
(c) the standard error of the data.

Question 4 [10%]

The best measurement for the speed of light is c = 299792.458 km/s. You do yourself an experiment to obtain the speed of light. Your result is 299795 ± 2 km/s. Compute how many error bars your measurement differ from the best value. Is your result in good agreement or consistent or problematic?

Question 5 [20%]

The rotational inertia (I) of a pulley is given by



$$I = \frac{1}{2} m R^2$$

where

m is the mass of the pulley

R is the radius of the pulley

Calculate the rotational inertia of the pulley and its uncertainty for $m = 2.00 \pm 0.05$ kg and $R = 0.40 \pm 0.01$ m.

Question 6 [20%]

A discrete random variable is defined as the set: H = {1.8 , 3.3 , 5.7 , 7.1 , 9.2}

with probabilities: P(H) = {0.1 , 0.3 , 0.3 , 0.2 , 0.1}

a) Calculate the expectation (mean) value

b) Calculate the standard deviation

EP122-2014-mt1_Formula_Sheet

$\bar{x} = \frac{1}{N}\sum_{i=1}^{N} x_i \qquad \sigma = \sqrt{\frac{1}{N-1}\sum_{i=1}^{N}(x_i - \bar{x})^2} \qquad \sigma_E = \frac{\sigma}{\sqrt{N}}$	$\bar{x} = \frac{\sum_{i=1}^{n} x_i / \sigma_i^2}{\sum_{i=1}^{n} 1/\sigma_i^2} \qquad \bar{\sigma} = \frac{1}{\sqrt{\sum_{i=1}^{n} 1/\sigma_i^2}}$
$\sigma_f^2 = \left(\frac{\partial f}{\partial x_1}\right)^2 \sigma_1^2 + \left(\frac{\partial f}{\partial x_2}\right)^2 \sigma_2^2 + \cdots + \left(\frac{\partial f}{\partial x_n}\right)^2 \sigma_n^2$	$E[X] = \sum_i x_i \; f(x_i) \qquad E[X] = \int_{-\infty}^{+\infty} x \; f(x) dx$ $E[X^2] = \sum_i x_i^2 \; f(x_i) \qquad E[X^2] = \int_{-\infty}^{+\infty} x^2 \; f(x) dx$
$P_{binom} = \binom{n}{k} (p)^k (1-p)^{n-k}$ $P(A \cup B) = P(A) + P(B) - P(A \cap B)$ $P_{poisson} = \frac{e^{-\lambda}\lambda^k}{k!} \quad (\lambda = np) \qquad P(B \mid A) = P(A \cap B) / P(A)$	$\sigma^2 = E[X^2] - (E[X])^2$ $= \langle X^2 \rangle - \langle X \rangle^2$ $RMS = \sqrt{E[X^2]}$

End