Entrance Examination for Engineering Education
Finnish Universities of Applied Sciences

Test of Mathematics, Logical Deduction, Physics and Chemistry, and English language

April 25th 2013

Name of Applicant (in Print):

_____

Applicant Number:

_____

Invitation received from (Name of University of Applied Sciences):

_____

Degree Program:

_____

Entrance Examination
for Engineering Education
Finnish Universities of Applied Sciences
April 25th, 2013

INSTRUCTIONS

The examination consists of two parts:
Part 1: Mathematics, Logical reasoning, Physics and Chemistry.
Part 2: English language.

The total duration of exam is 4 hours.
There is no break between the two parts.
You may not leave the examination room within the first 30 minutes.

The test in Mathematics, Logical reasoning, Physics and Chemistry

You may only bring your writing material (pencil, sharpener, rubber and ruler) and your calculator* to the examination. Formula books and dictionaries are not allowed.

Answer sheets and extra paper are distributed with the exam papers.
There are 10 problems to be solved; each worth 3 points.

Write your solutions in the provided space on the answer sheets and the final answer in the specified place.

For problems 8, 9 and 10, you have to choose either A (Physics) or B (Chemistry). If you solve both, the one with the lower score will count.

Include calculation details whenever the solution requires calculations.

Only solutions written on your answer sheets will be checked!

All papers must be returned.

***Your calculator has to be a basic pocket calculator which is non-programmable and with no graphics properties.**

Your mobile phone must be switched OFF.

Use of any communication device is denied.

Each problem is worth 3 points and maximum is 10x3 points.

1. Solve the following equations of real number x.

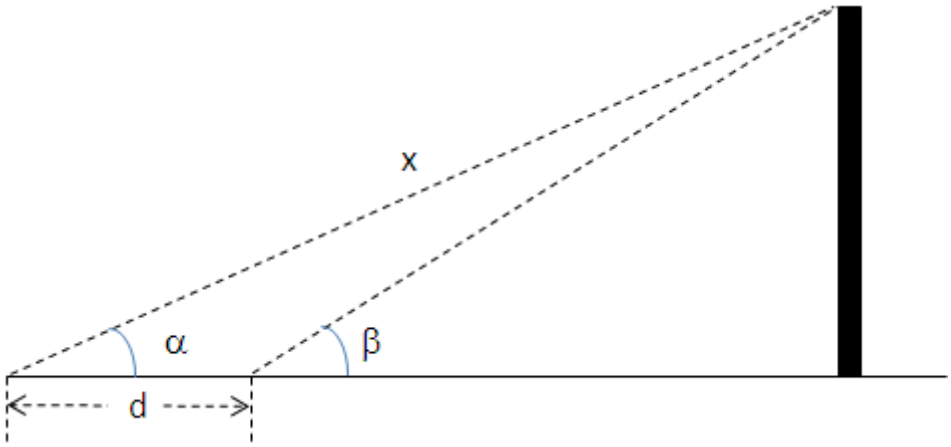
   a) $9x-2=-2(3x-1)+12x$

   b) $1+\frac{x-1}{2}-\frac{x+1}{4}=\frac{x+3}{3}$

   c) $\frac{x+3}{x-1}=-\frac{1}{2}(x+3)$

2. Achilles is asked to race against the tortoise in 5000 -meter run, with the condition that the tortoise is given head start. Achilles knows that his velocity is ten times the velocity of tortoise. What can the head start be at most in order that Achilles would win the race?

3. Determine the distance x to the skyscrapers peak, if $\alpha=24^\circ$, $\beta=32^\circ$ and $d=200$ meters.



4. A new test for human immunodeficiency virus (HIV) was developed.
   It was tested using 1000 test subjects of which 70% were known to be HIV-negative and the remaining 30% known to be HIV-positive.

   In the study the HIV-test detected
   - HIV-positivity in 80% of the test subjects known to be HIV-positive
   - HIV-negativity in 90% of the test subjects known to be HIV-negative

   a) Determine the total percentage of the test subjects that *were HIV-negative according to test* **and** *were known to be HIV-negative.*

   b) Determine the total percentage of the test subjects that *were HIV-negative according to test.*

5. The placement of waste disposal area has to be selected. In the selection two criteria are taken into account: the effects on water systems and the effects on soil. In the table below you find four alternatives, which are assessed by an expert with a number between 0 and 100 according to both criteria, where large number indicates less pollution.

Alternative i	**Effects on water systems** w_i	**Effects on soil** l_i
1	90	10
2	60	80
3	20	90
4	50	70

The goodness of each alternative i will be assessed using the following goodness function

$$g_i(x) = x \cdot w_i + (1-x) \cdot l_i$$

Here x ($0 \le x \le 1$) is a weight coefficient which will be given by the decision-maker.
The alternative with greatest goodness value will be chosen.
Which alternative (1, 2, 3 or 4) will be selected if the decision maker chooses the weight coefficient to be

a) $x = 1$?
b) $x = 0.6$?

c) Are there any alternatives that will not be selected with any weight coefficient x ? List their numbers (if there are any).

6. Let * (called *product*) and + (called *sum*) be arithmetic binary operators, that is, they take two operands (variables or constants). Often arithmetic expressions are written using *infix notation*, that is, operators are written between operands and parentheses are demanded to determine the computation order in a natural way. In expressions it is meaningful whether an operand is situated to the left or right of an operator. For example, *A**(*B* + *C*) denotes for "product of *A* and sum of *B* and *C*". However, some devices demand that arithmetic expressions are written without parentheses using *Polish postfix notation*, that is, operators are written *after (right of)* operands. For example, the expression *A*+*B* is written using Polish postfix notation as *AB*+ and *A**(*B* + *C*) is written using Polish postfix notation as *ABC*+*. Write the following (infix notation) expressions using Polish postfix notation:

a) *A*+(*B***C*)
b) ((*A***B*)+*C*)**D*

7. Which **one** of the following statements you consider to be logically the same (have the same logical content) as *if x is a computer then x has a memory.*

a) *x is a computer and x has a memory.*
b) *if x does not have a memory then x is not a computer.*
c) *if x has a memory then x is a computer.*
d) *if x is not a computer then x does not have a memory.*

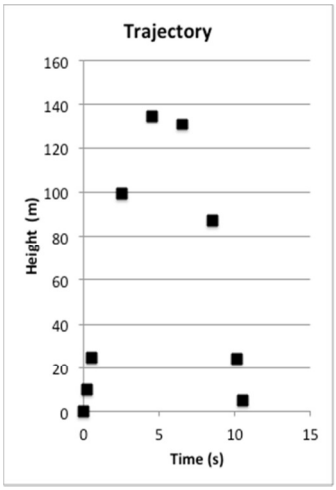
Problems 8, 9 and 10:
Solve only A or B. If you solve both, the problem with lower score will count.

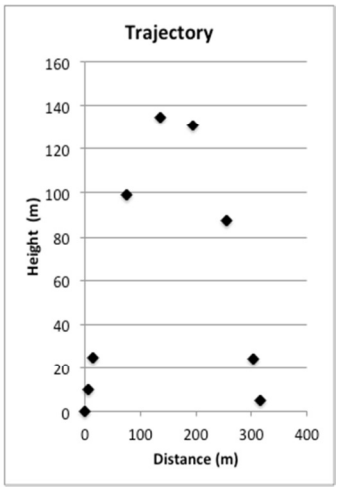
8A. A baseball is thrown into air. The horizontal and vertical distances are measured at different times for the baseball. The measurement results are presented in the table and graph below. The mass of the baseball is 142 g and the gravity constant g = 9.81 m/s2. Use the given data to calculate or figure out by reasoning the correct answer to the following questions. You can ignore the air drag.
Based on your calculation and reasoning, select the best fitting among the given answers.

$v = v_o + at$ and $x = v_o t + \frac{(at^2)}{2}$

a) Calculate the initial velocity of the ball from the given data. Give the answer as the initial speed and angle.
Initial speed = [25 / 30/ 4 5/ 50 / 60] m/s, and
Initial angle = [10 / 20 / 30 / 40 / 60] degrees
b) At which time does the ball reach the maximum height?
Time = [2.50 / 3.02 / 4.62 / 5.30 / 10.50] s
c) What is the velocity of the ball at the maximum height?
Velocity2 = [0 / 20 / 3 0 / 40 / 60] m/s

Time (s)	Horizontal distance (m)	Vertical height (m)
0,00	0,00	0,00
0,20	6,00	10,20
0,50	15,00	24,75
2,50	75,00	99,25
4,50	135,00	134,50
6,50	195,00	130,51
8,50	255,00	87,29
10,10	303,00	24,45
10,50	315,00	4,82





8B. Hydrochloric acid (HCl, 1 mol/L) is diluted with another liquid. The final volume is 1000 liters.
What is the volume of acid needed in the following cases:
a) The diluting liquid is pure water and the final pH = 3
b) The diluting liquid is pure water and the final pH = 4
c) What is the *approximate* volume of hydrochloric acid needed if the diluting liquid is 0.010 mol/L potassium hydroxide (KOH) solution and the final pH = 4?

Justify your answer by calculation and answer to each part a), b), and c) by writing one of the following volumes: 0.05 L / 0.10 L / 0.5 L / 1.0 L / 2.5 L / 5.0 L / 10 L / 50 L

L denotes litres.

9A. Felix Baumgartner made the new world record jump in October 14th, 2012. He rose up with helium filled balloon until it stopped at 39 km altitude and then he jumped down. Before the launch the balloon was filled with $8.34 \cdot 10^3$ m^3 of helium. The helium expanded and filled the balloon to the maximum volume of $8.34 \cdot 10^5$ m^3 at the jump altitude. The mass of the balloon canvas with the ropes was 1682 kg, the mass of the capsule 1315 kg, and the mass of Felix in full gear 200 kg.
At the sea level the density of helium is 0.179 kg/m3 and the density of air is 1.2 kg/m3.

a) What was the initial acceleration of the balloon (just after it has been released)?
b) Calculate the density of air at the altitude of 39 km.
c) The maximum speed during the free fall, 1343 km/h, was reached in 38 s. After that the air drag started to affect and Felix opened his parachute at the altitude of 1524 m when the speed was reduced to 277km/h. The total time of the free fall was 4 min and 22 s. Calculate the average acceleration caused by the effect of the air drag.

9B. Nickel is produced in a mining company by biological dissolution and thereafter precipitation of nickel from the solution. The ore contains 0.34 % nickel sulfide (NiS). What is the mass of nickel produced from 1 ton of ore? Ignore possible losses during the process.
$M_{Ni} = 58.7$, Ms = 32.1

10A. You take a 0.5 L bottle of water (5 °C) from a refrigerator, and pour it into a glass. How many ice cubes, 0 °C, do you need to cool your drink down to 1 °C, if the mass of each ice cube is 10 g? The heat of fusion of water is 333 kJ/kg, and the specific heat of water is 4.19 kJ/(kg · °C).

10B. 2.0 m^3 of butane (C_4H_{10}) is burned.

a) Write the reaction equation.
b) Calculate the volume of CO_2 produced in burning.

All volumes are measured at STP (standard conditions: 0^oC, 101.3 kPa).
Molar volume V_{mol} = 22.4 L/mol; Universal gas constant R = 8.31 J/(K· mol)

Entrance Examination
for Engineering Education
Finnish Universities of Applied Sciences
April 25th, 2013

The English test

The English test is compulsory to all applicants and must be passed.

Each reading comprehension true/false question is worth 1.5 points.
Each grammar/vocabulary multiple choice question is worth 1.5 points.
Writing test is worth 15 points.

Answer on the provided answer sheet.

All papers must be returned.

Read the text and decide whether the statements after the text are true or false.
Use the answer sheet provided for all tasks of the language test.

DROUGHT AND CLIMATE CHANGE

Adapted from The Economist December 1st 2012

When the worst drought in 60 years hit America's cornbelt this summer, many people wondered if it was caused by climate change. It is too early to say much about such a recent episode but various studies have attributed earlier individual heat waves or drought to global warming. The most recent assessment (2007) by the Intergovernmental Panel on Climate Change (IPCC) said bluntly:

"Higher temperatures and decreased precipitation have contributed to changes in drought."

Global warming might cause drought because warm air holds on to water vapour, making rain even less likely in places that are already dry. But a study published recently in *Nature* casts doubts about whether that is actually happening.

Drought is an imprecise term. Arid conditions in one area count as plentiful rainfalls in another. To make matters more exact, scientists employ an index, called the Palmer index, to monitor changes in agricultural conditions. This index uses precipitation and temperature data to calculate evaporation rates and hence moisture levels in the soil. Because temperature plays such a big role, the index is sensitive to global warming.

The trouble is, argue the authors of the study, Justin Sheffield, Eric Wood and Michael Roderick that "evaporation is a function of more than just temperature." Wind-speed, vapour pressure, clouds and many other factors matter. Until recently, there have not been adequate data on these to feed into the index.

To test the effect of these other factors, the authors calculated the Palmer index using two different methods: the traditional temperature-based one and another that includes more varied meteorological information. For 1980 – 2008 the temperature-based index rises in 98% of the world's land area. The new index rises in only 58% of the land area and falls in a significant minority of places. So it may be that the perception of a global increase in the droughts is driven by local increases.

Kevin Trenberth, who co-ordinated the relevant IPCC report claims the study is skewed by the way the authors calculate the influence of humidity, winds and clouds, on which data are patchy. Another recent article, in *Nature Climate Change*, by Aiguo Dai, uses a different set of data for precipitation and gets a different result: that drought is indeed getting worse.

A report published by an IPCC in June admits." Definitional issues, lack of observational data and the inability of the models to include all factors preclude stronger confidence than medium in drought projections." Piers Foster of the University of Leeds concludes that "the study in *Nature* is an important contribution highlighting the complexity of drought prediction but it does not make me downgrade the substantial threat to harvests posed by climate change."

ARE THE STATEMENTS TRUE OR FALSE?

Read the statements concerning the text above on the answer sheet and give T or F as answer.

VOCABULARY AND GRAMMAR

Read the sentences on the answer sheet and choose the right alternatives.

WRITING TEST

You have decided to study to be an engineer. Before that you have probably studied and learnt a lot about engineering as a profession. Write about your findings, e.g. what kind of responsibilities engineers have, what is required, what kind of challenges they meet, why the engineer's work is interesting. Imagine that you are writing to a young person who hasn't made up his/her mind about a career yet.

Write about 15 – 20 sentences on the answer sheet provided for your writing task.

Title your text as ENGINEERING AS A PROFESSION.