Aarhus University School of Engineering

Electronic- & Information Technology- & Electrical Power & Healtcare Engineering

Term:	**Q4 exam – Summer 2017**
Test in:	**ETSMP – Stochastic Modelling and Processing**
Date:	June 16, 2017
Duration:	3 hours
Supervisor:	Lars Mandrup

Aarhus University School of Engineering will hand out:
2 covers plus paper for draft and fair copy will be handed out. The student must fill out and hand in **2** covers. The student should only upload / hand in **1** paper.

Digital Exam
This examination is part of "Digital Exam". This means that the assignment will be distributed and submitted via the digital exam platform. Hand written parts of the answers must, however, be submitted in the covers.

If you submit everything by hand, you **MUST** upload a document via the digital exam platform, stating that you have submitted your answers by hand.

You will receive an electronics delivery receipt as soon as you have handed in. Remember to submit on time, as otherwise a dispensation application must be submitted.

Answers submitted via the digital exam platform must be submitted in PDF format. Please remember to write your name and student number on **ALL** pages and in the document title / filename.

Aids:
All materials are permitted, including the internet as an encyclopedia, and it is **NOT** allowed to communicate with others electronically or otherwise during the exam.

Remarks:
At assessment, all part-assignments will be weighted the same.

All electronic answers must be submitted in pdf format. If the answer is made In Mathcad Prime, you must also submit it as an attachment iasMathcad Prime.

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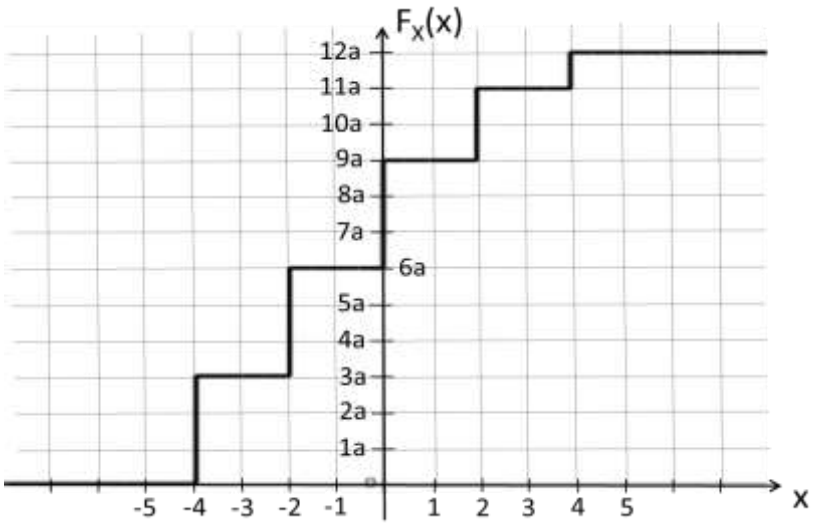
Assignment 1

A discrete stochastic variable X has the following cumulative distribution function (cdf) $F_X(x)$:



a) Determine a, so $F_X(x)$ is an allowed distribution function.

b) Determine and sketch the probability mass function (pmf) $f_X(x)$.

c) Calculate the mean value for X.

d) Calculate the variance for X.

Assignment 2

In June (30 days) it is raining 20% of the days in average in the first half part of the month and 30% of days in the last half part of the month.

a) How many days will it on average rain i June?

b) If we experience a day of rain in June, what is the likelihood that we are in the last half of the month?

c) What is the probability that it will rain **no more than** 1 day in the first half of the month?

Assignment 3

A continuous stochastic process X(t) is given by:

$$X(t) = (-1)^n + W$$

where W are i.i.d. Gaussian distributed stochastic variables W ~ $\mathcal{N}(0; 0{,}25)$, and n independently can have the values 0 and 1 with equal probability.

a) Sketch 3 realizations of the process X(t) in the interval 0≤t≤5. State how the 3 realizations are made.

b) Calculate the mean and variance for one of the realizations.

c) Calculate the ensemble mean and variance for the process X(t).

d) State whether the process is WSS (wide sense stationary), and whether it is ergodic. State the reason behind your answers.

Assignment 4

A quality check measures the accuracy of two different types of GPS. For both types, the deviation between their actual position $(d_{faktisk})$ and the GPS (d_{gps}) was measured:

$$d_i = \left|d_{i,gps} - d_{i,faktisk}\right|$$

It is assumed that the deviations are normally distributed.
There are 10 GPS of type 1 tested and 12 GPS of type 2.
For type 1 the mean deviation was estimated to $\widehat{\mu_1} = 5{,}21\ m$ with an estimated variance $s_1^2 = 1{,}33\ m^2$.
For type 2 the mean deviation was estimated to $\widehat{\mu_2} = 4{,}18\ m$ with an estimated variance $s_2^2 = 0{,}89\ m^2$.

a) Setup a hypothesis test to determine whether the mean deviations for the two types of GPS are equal.

b) Estimate the difference in the mean deviations $\hat{\delta}$ for the two types of GPS.

c) Estimate the variance $\hat{s}^2$ for the difference between the two types of GPS.

d) Use a t-test to test your hypothesis. Can the NULL-hypothesis be rejected with a significance level of 0,05? State a reason for your answer.

e) Calculate the 95% confidence interval for the difference of the mean deviations δ.