NTNU – Trondheim
Norwegian University of
Science and Technology

Department of Production and Quality Engineering

Examination paper for TPK4140 MAINTENANCE MANAGEMENT

Academic contact during examination:	**Per Schjølberg**
Phone:	**930 03 840**
Examination date:	**20.12.2013**
Examination time (from-to):	**09:00 – 13:00**
Permitted examination support material:	**D (**No printed or written aids allowed, specified simple calculator allowed)

Other information: Pencils are allowed, but do not use red colored pencil! The student can choose to write the answers in English or Norwegian or a combination of these.

Language:	**English**
Number of pages:	**4 (front page included)**
Number of pages enclosed:	**0**
Evaluation deadline:	**20.01.2014**

Checked by:

_____

Date Signature

Tentative solution

3a)
Replacing the unit at age τ, paying C_R once. Expected # of failures in a an interval of length τ is $W(\tau)$, and the corresponding cost per failure is C_F. Expected cost in a period will then be:

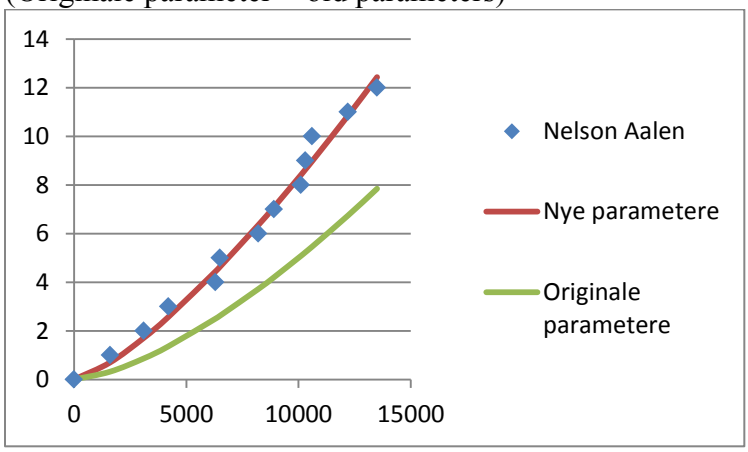
$$C(\tau) = \frac{C_R + W(\tau)C_F}{\tau} = \frac{C_R + \lambda\tau^{\beta}C_F}{\tau} = \frac{C_R}{\tau} + \lambda\tau^{\beta-1}C_F.$$

Differentiation of $C(\tau)$ wrt τ gives

$$C'(\tau) = -\frac{C_R}{\tau^2} + \lambda(\beta-1)\tau^{\beta-2}C_F.$$

$C'(\tau) = 0$ gives $\tau = \left(\frac{C_R}{\lambda(\beta-1)C_F}\right)^{1/\beta} \approx 15\,874.$

3b) +3c) Nelson Aalen plot with overlay curves (Nye parameter = new parameters), and (Originale parameter = old parameters)



3d) Inserting new parameters in the cost equation gives a new interval: $\underline{\tau \approx 14\,966}$.
Corresponding cost function $C(\underline{\tau}) = 12.89$, while inserting the old τ-value in the new cost function gives a marginal cost increase of 0.06%.

4a) See course compendium

4b)

Parameter	Value	
MTTF	21 900	
α	4	
C_{PM}	2 500	
C_{CM}	5 000	
MDT	16	
p	15 %	
C_U	20 000	
C_T	50 000	
tau	8 307	Mainteance interval
PM-cost	0.30	=CPM/tau
CM-cost	0.01	=LambdaEWApproxSimple(tau,MTTF,alpha)*CCM
Failure-cost	0.09	=LambdaEWApproxSimple(tau,MTTF,alpha)* p*(CU*MDT+CT)
C(tau)	0.40	=PM_cost+CM_cost+Failure_cost