ELT-53606, Network analysis and dimensioning I

Exam date: 16.12.2014

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Return to: TG411

No calculators allowed! Please answer in the order of questions.

Part 1: Theoretical questions

Answer the following questions.

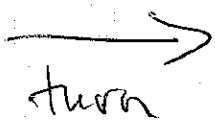
1. What are the time-advance methods in discrete-event simulation?
2. What is the event list?
3. What structures are used to organize event lists?
4. What is the general procedure to generate random numbers in simulations?
5. What is the basis of linear congruental generators?
6. What methods of data collection exist? Why we need them?
7. How to decrease the effect of transient periods?
8. How quickly confidence limits shorten increasing the number of experiments?
9. Explain the idea of the method of antithetic variables.
10. Give a definition of a memoryless property.
11. Which two distributions are memoryless?
12. How memoryless distributions are related to Markov chains?
13. Which quantities does Little's law relate?
14. Formulate PASTA property.
15. Formulate Kleinrock's principle?

Part 2: Theoretical analysis

16. **Consider M/M/1 queue, λ, μ – arrival and service rates.**
    - I. What is the equilibrium condition for this system? Why? Explain.
    - II. How the system state is defined? Why is it possible? Explain.
    - III. Draw Markov chain associated with your system.
    - IV. Get a global balance equation for state 3.
    - V. Get differential equations describing time-dependent behavior.
    - VI. Get linear equations describing the system at steady-state.
    - VII. Derive an expression for steady-state probabilities.
    - VIII. Derive an expression for mean number of customers in the system.
    - IX. Derive an expression for mean waiting time in the system.

Hint: it is not needed to determine the sum of series you may encounter.

17. **Consider M/G/1 queuing system. Complete the following tasks.**
    - I. Name the methods applicable for this system.
    - II. How time points of imbedded Markov chain should be chosen? Why?
    - III. How the state of the system can be defined? Why is it possible? Explain.
    - IV. Draw state transition diagram of imbedded Markov chain.



Part 3: Numerical evaluation

18. **For a computing system with one processor the processing time per customer is exponentially distributed with an average time of 6 minutes. Customers arrive according to Poisson process at an average rate of one customer every 8 minutes and are processed on a FIFO basis. Determine:**
    I. Kendall's notation of the queuing system;
    II. Mean number of customers in the system;

Hint: the mean waiting time in the system: $E[W] = \frac{1}{\mu(1-\rho)}$.

    III. Probability that a customer is delayed for more than 20 minutes.

Hint: distribution of sojourn time in the system is: $W(t) = \Pr\{w \le t\} = 1 - e^{-\mu(1-\rho)t}$.