# Försättsblad till skriftlig tentamen vid Linköpings universitet

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|---|---|
| **Datum för tentamen** | 2019-03-18 |
| **Sal (2)** | G37(1) U1(36) |
| **Tid** | 14-18 |
| **Utb. kod** | TDDD25 |
| **Modul** | TEN1 |
| **Utb. kodnamn/benämning**<br>**Modulnamn/benämning** | Distribuerade system<br>Skriftlig tentamen |
| **Institution** | IDA |
| **Antal uppgifter som ingår i tentamen** | 14 |
| **Jour/Kursansvarig**<br>Ange vem som besöker salen | Petru Eles |
| **Telefon under skrivtiden** | 070-368 13 96 |
| **Besöker salen ca klockan** | 15:30 |
| **Kursadministratör/kontaktperson**<br>(namn + tfnr + mailaddress) | Carita Lilja<br>013 28 1463<br>carita.lilja@liu.se |
| **Tillåtna hjälpmedel** | Engelsk ordbok |
| **Övrigt** | - |
| **Antal exemplar i påsen** | |

LINKÖPINGS TEKNISKA HÖGSKOLA
Institutionen för datavetenskap
Petru Eles

# Tentamen i kursen

# Distribuerade System- TDDD25

# 2019-03-18, kl. 14-18

**Hjälpmedel:**

Engelsk ordbok.

**Supporting material:**

English dictionary.

**Poänggränser:**

Maximal poäng är 40.
För godkänt krävs sammanlagt 21 poäng.

**Points:**

Maximum points: 40.
In order to pass the exam you need a total of minimum 21 points.

**Jourhavande lärare:**

Petru Eles, tel. 0703681396

## Good luck !!!

**Tentamen i kursen Distribuerade System -TDDD25, 2019-03-18, kl. 14-18**
**Du kan skriva på svenska eller engelska!**

1. Synchronous and asynchronous distributed systems. What are their main features and what are the consequences of these features?

(3p)

2. How can *exactly once semantics* be achieved in the case of lost messages (assuming the server never crashes)?

(2p)

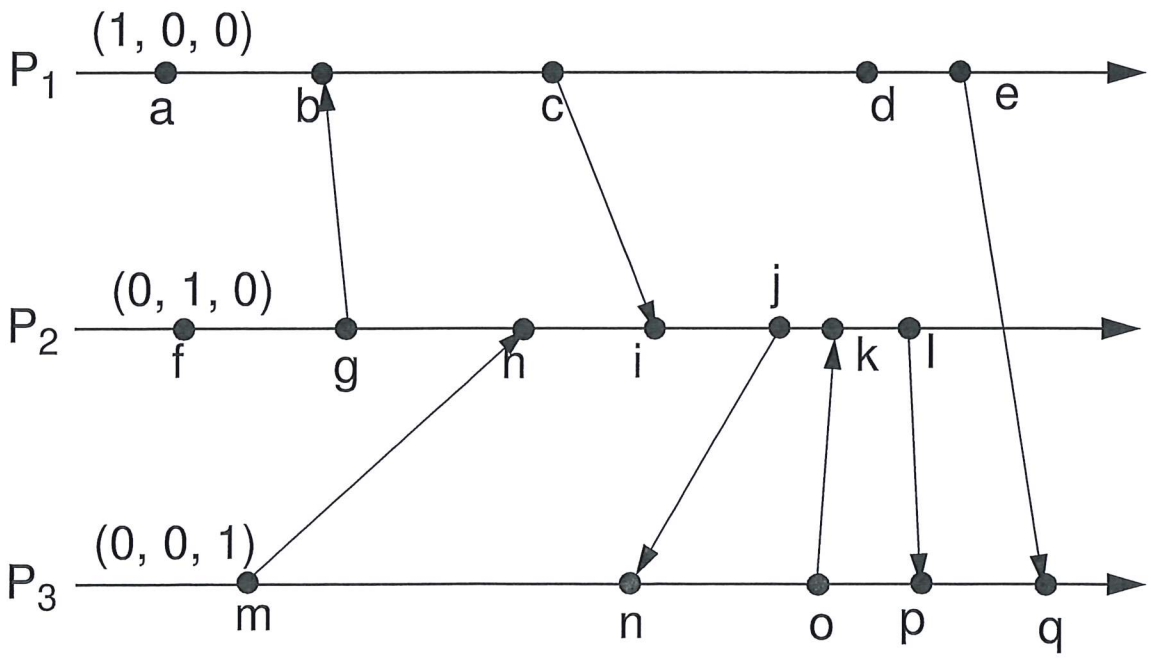
3. Publish-Subscribe systems:
   a) Draw a figure in which you illustrate the three players (publishers, subscribers, and notification service) and their interaction.
   b) Explain the filtering function and illustrate by an example.

(3p)

4. BitTorrent and Napster:
   a) Explain how each of them works; illustrate by a figure indicating the successive steps performed for access.
   b) Compare the two.

(3p)

5. Consider the following set of events:




Assign the missing vector clock values to the events.

(3p)

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6. Consider a system of four processes $P_1$, $P_2$, $P_3$, $P_4$. Consider the events $a$ in $P_1$, $b$ in $P_2$, $c$ in $P_3$, and $d$ in $P_4$.
   a) Let us consider a case such that the Lamport's logical clock timestamps associated to the events are the following:
   $C(a) = 1$; $C(b) = 3$; $C(c) = 3$; $C(d) = 2$;
   What can you say regarding the happened before relation between events $a$, $b$, $c$, $d$ (consider each pair of events)?
   b) Let us consider a case such that the vector clock timestamps associated to the events are the following:
   $C^V(a) = (2,0,0,1)$; $C^V(b) = (2,3,1,2)$; $C^V(c) = (3,2,2,1)$; $C^V(d) = (2,0,0,2)$;
   What can you say regarding the happened before relation between events $a$, $b$, $c$, $d$ (consider each pair of events)?

(3p)

7. We have introduced a theorem saying that a cut is consistent "if and only if no two cut events are causally related".
   a) Illustrate the theorem with two examples (one showing a consistent cut and the other an inconsistent one). Use figures!
   b) Show, for each example, how the theorem applies.

(3p)

8. Consider a bully election with 6 processes, $P_1$, ..., $P_6$. $P_6$, the current coordinator, fails and $P_3$ starts the election. Illustrate the sequence of messages exchanged (use figures).

(3p)

9. Considering 5-modular redundancy, illustrate with examples how each of the following three voting approaches works: (1) majority voting, (2) 2-plurality voting, (3) median voting.

(3)

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10. Explain the following types of redundancy:
    - Time redundancy
    - Hardware redundancy
    - Software redundancy
    - Information redundancy

(3p)

11. The Byzantine Generals Problem: show how agreement is not or is possible for three and for four participants respectively, in the case one of the generals (not the commander) is a traitor (illustrate the exchange of messages with figures).

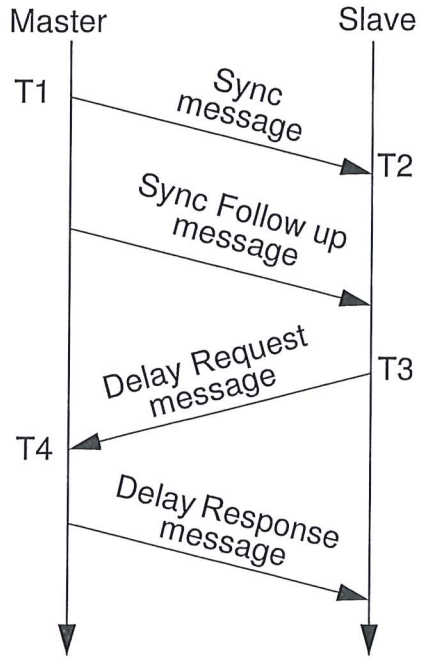
(3p)

12. What does it mean by external and internal synchronization of physical clocks?
    What does it mean by centralized and distributed synchronization algorithms?

(2p)

13. You know the maximum drift rate of the clocks on two processors and the maximal allowed skew between them. How do you determine the maximum interval between two successive synchronizations between the clocks? Consider both the case when after synchronization the clocks are perfectly aligned and the case when after synchronization there exists an offset $\Phi$ between the clocks.

(3p)




14. The figure shows the message exchange performed for clock synchronization in the Precision Time Protocol (PTP).
    a) What is the role of the "Sync Follow up message"? Why is it needed?
    b) What information is the "Delay Response message" carrying?
    c) Once the values T1, T2, T3, T4 are known, how is the clock update performed?

(3p)