

The final exam consists of **six** questions (each worth 25 points). You **must** answer the **three** Required Questions and any **three** of the Optional Questions. Put all your answers in blue books with your name on each book and indicate on the outside which questions are in each book. If you answer more than three of the optional questions, you **must indicate the three you want to be graded.**

**Three Required Questions [answer ALL three questions]**

On Designing Improved Controllers for AQM Routers Supporting TCP Flows

- 1a. Discuss the limitations of the Proportional Controller.
- b. Give the pseudo code for the PI controller.
- c. Explain the computational differences between PI and RED that includes the PI parameters and how they are derived.
- d. Use the results of two experiments to demonstrate the advantages of PI over RED. What disadvantages does PI have?

A Performance Comparison of Multi-Hop Wireless Ad Hoc Network Routing Protocols

- 2a. Explain the differences between Link State and Distance Vector routing.
- b. Explain the DSDV and DSR ad hoc routing protocols,
- c. Define the following three metrics: packet delivery ratio, routing overhead and path optimality.
- d. Use these metrics to discuss the performance differences between DSDV and DSR demonstrated in the paper.

CARA: Collision-Aware Rate Adaptation for IEEE 802.11 WLANS

- 3a. Explain the concept of CSMA/CA with RTS/CTS.
- b. What are hidden terminals, and how do they impact performance?
- c. What are the inherent performance tradeoffs of using RTS/CTS in 802.11?
- d. How does CARA use RTS probing and Clear Channel Assessment to outperform ARF?

**Six Optional Questions [answer ANY three questions]**

## Core-Stateless Fair Queueing

- 4a. Explain the Fair Queueing mechanism for congestion control at a router.
- b. Explain the CSFQ architecture including the estimates used in the packet algorithm.
  - c. Discuss CSFQ performance when compared with FIFO, RED and DRR via ns-2 simulations.
  - d. Discuss the advantages and disadvantages of CSFQ versus RED with respect to handling Web traffic and UDP traffic.

## Improving TCP Performance over Mobile Ad Hoc Networks by Exploiting Cross-Layer Information Awareness

- 5a. Briefly describe the EPLN and BEAD mechanisms.
- b. Explain the concept of TCP being frozen.
  - c. Discuss the tradeoffs between freezing TCP upon route failures and upon packet losses.
  - d. How does cross layer information awareness help in improving TCP performance in ad hoc networks?

## Characterization and Analysis of Multi-Hop Wireless MIMO Network Throughput

- 6a. Describe spatial reuse and explain how it can improve performance in a MIMO wireless network.
- b. Describe spatial division multiplexing and explain how it can improve performance in a MIMO wireless network.
  - c. Explain the changes in performance of SRP and SMP as more antennas are added to each node.
  - d. Under which conditions do SRP or SMP offer better performance?

### Defending against Distributed Denial of Service Attacks: A Tutorial

- 7a. Explain how direct and reflector DDoS attacks work.
- b. Explain Attack Detection and Filtering as a line of defense against DDoS attacks.
- c. What are the issues to be faced when attack detection and filtering is performed:
  1. at the source networks
  2. at the victim's network
  3. at a victim's upstream ISP network?
- d. Explain the basic idea in the RPF approach.

### Secure Routing in Wireless Sensor Networks: Attacks and Countermeasures

- 8a. Explain some of the characteristics of a WSN that make routing security difficult to implement.
- b. Name and explain the two new classes of security attacks on WSN routing introduced by the authors.
- c. Describe possible countermeasures for these two attacks.
- d. Explain the TinyOS beaconing routing protocol for WSNs and describe one laptop-class adversary attack for this routing protocol.

### WiseMAC: An Ultra Low Power MAC Protocol for the Downlink of Infrastructure Wireless Sensor Networks

- 9a. Describe the WiseMAC protocol in an infrastructure WSN.
- b. How does WiseMAC minimize the time that sensor nodes spend in idle listening?
- c. How does WiseMAC mitigate overhearing?
- d. How does clock drift affect the duration of WiseMAC's wakeup preamble?
- d. Under what conditions does WiseMAC consume more power than Zigbee, and why does this occur?