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 of the blue book 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]

TCP Sliding Windows and Congestion Control

1 a. Explain the difference between the advertised window and the congestion window in TCP.

 b. Explain the concepts of slow start, fast retransmit and fast recovery in TCP Reno and their effects on TCP performance.

 c. Explain the Explicit Congestion Notification (ECN) congestion control scheme at a router. What are the advantages and disadvantages of this scheme?

 d. Discuss the reasons for the shift away from TCP Reno and towards TCP Compound and TCP Cubic as new TCP variants.

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

2 a. Explain the differences between Link State and Distance Vector routing.

 b. Explain the TORA 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 TORA and DSR demonstrated in the paper.

Power-Aware MAC WSN Protocols

3 a. Explain the differences between sender-initiated and receiver-initiated WSN MAC protocols.

 b. Draw diagrams (for all three protocols) and explain the differences between sender and receiver behavior for X-MAC, A-MAC and ContikiMAC.

Six Optional Questions [answer ANY three questions]

Core-Stateless Fair Queuing

4 a. Explain the Fair Queuing 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.

An Analysis of the Skype Peer-to-Peer Internet Telephony Protocol

5 a. Explain the difference between the Host Cache and the Buddy List in Skype.
   b. Discuss the purpose of Bootstrap Supernodes in Skype. How does the Skype client find out about these nodes?
   c. Explain the steps taken by the Skype protocol when a three-way conference is established.
   d. Explain how media is transferred between users who are behind NATs.

DDoS Defense by Offense

6 a. What are the two conditions necessary to make speak-up a viable defense?
   b. Why must these conditions be present for speak-up to work?
   c. Explain the role of the 'thinner' in speak-up.
   d. Discuss adequate provisioning of the 'thinner' for speak-up to work properly.

CARA: Collision-Aware Rate Adaptation for IEEE 802.11 WLANS

7 a. Explain how ARF works.
   b. Describe how CARA differentiates collisions from channel errors.
   c. What are the differences between CARA-1 and CARA-2?
   d. Explain hidden terminals. How could they impact the performance of CARA?

Secure Routing in Wireless Sensor Networks: Attacks and Countermeasures

8 a. Explain some of the characteristics of a WSN that make routing security
      difficult to implement.
  b. Discuss in detail a Sybil attack and a Wormhole attack on WSN routing.
  c. Describe possible countermeasures for these two attacks.
  d. Explain the TinyOS beaconing routing protocol for WSNs and describe one
     adversary attack for this routing protocol.

An Empirical Study of UHF RFID Performance

9 a. Explain the concept of backscatter with respect to RFID reader and tag
      communications.
  b. Draw a diagram and explain the sequence of commands that make up a *Query
     Round.*
  c. Discuss two physical layer changes proposed by this paper and explain how these
     changes can enhance RFID performance.