CE 252: Computer Networks
Final Exam Study Guide (Learning Topics)

General Information

This final is a closed-book examination, and you are not allowed to use any slides, notes, or devices. You may use a 1-page cheat sheet (both sides) to write any details. You may also use a scientific calculator.

Learning topics

The exam will be based on the following learning topics:

1. The network layer – data plane:
- NAT: network address translation
  - Incoming and outgoing datagrams
  - NAT translation table
- DHCP: dynamic host configuration protocol
  - DHCP discover, offer, request, Ack
  - Client-server
- IPv6
  - IPv6 datagram
  - Key differences with IPv4
- Translation from IPv4 to IPv6
  - Tunneling
  - Adoption
- Generalized forwarding and SDN
- OpenFlow data plane abstraction

2. The network layer – control plane:
- Control plane – routing
- Implementation in the Internet
- Routing protocols
  - Intra-domain versus Inter-domain
  - Global (centralized) versus Local (decentralized)
  - Static versus dynamic
- Model of network topology
  - Graph
  - Nodes
  - Edges
  - Costs of links
- Link-state routing
  - Dijkstra algorithm
  - Per-router forwarding table
- Distance vector routing
  - Bellman-Ford dynamic programming
  - Per-router distance vector
  - Link costs changes and convergence
    - Poisoned reverse
- Routing in the Internet
  - Autonomous systems (AS)
  - Inter-AS routing: BGP, Path vector
  - Intra-AS routing: OSPF, RIP, IGRP
- Hierarchical routing – OSPF
  - OSPF areas
  - Router classification
  - OSPF link-state advertisements and protocol packets
  - Types of LS advertisements
- RIP – Routing information protocol
- Inter-AS routing: BGP
  - eBGP
  - iBGP

    - Policy criteria
    - BGP basics
    - Path attributes and BGP routes
    - BGP path advertisement
    - BGP operation
- BGP, OSPF forwarding table
- “Hot potato” routing
- Network management
    - NOC
    - SNMP and network management tools
- SNMP protocol
    - Infrastructure for network management
        - Managing server
        - Agent
        - Managed device
        - MIB
    - SNMP Message Types
- ICMP
    - ICMP to communicate network-level information
    - ICMP message types
- SDN: Software Defined networks
    - Flow-based forwarding
    - Separation between data plane and control plane
    - Network control functions
    - Programmable network
- Data plane switches
- SDN controller and its components
- SDN controller applications
- OpenFlow protocol and messages
- OpenDaylight, ONOS, and Google B4 examples

3. Data link layer
- Services: framing, link access, reliable delivery, flow control, error detection/ correction
- Network interface card (NIC)
- Transmission errors
    - Single bit, multi bit, burst errors
- Error detection and correction codes
- Parity check
    - Single bit parity
    - Two-dimensional bit parity
- Checksum
- Internet checksum
- Cyclic redundancy check – CRC
- Link types
    - PPP
    - Broadcast
- Multiple access protocol (MAC):
    - Channel partitioning
        - TDMA, FDMA, CDMA
            - Efficiency
    - Random access
        - ALOHA: Slotted, Pure
            - Efficiency
        - CSMA
            - CSMA/CD
                - Efficiency
    - Taking turns
        - Polling
        - Token passing
- MAC/ LAN addresses

    - MAC address versus IP address
    - ARP protocol
- Routing between LANs
- The Ethernet
    - Dominant wired LAN technology
    - The physical topology
        - Bus versus Star
- Ethernet frame structure
- Ethernet unreliable, connectionless
- 802.3 Ethernet standards
- Ethernet switch
    - Multiple simultaneous transmission
    - Forwarding table
    - Self-learning
- Interconnecting switches
- Institutional network
- Switches versus routers
- VLANs
    - Port-based VLANs
- MPLS
    - MPLS routers
    - MPLS versus IP paths
    - MPLS signaling and forwarding tables
- The data center networks
    - A day in the life scenario

4. Wireless and mobile networks
- Wireless internet-connected devices
- Aspects of wireless and mobility
- Elements of wireless network
    - Infrastructure mode: Hosts, base stations, wireless links
    - Add hoc networks
- Characteristics of wireless networks
    - Range (meters) and capacity (bps)
- Difference between wireless and wired networks
- SNR versus BER
- Hidden terminal problem versus fading
- CDMA: 1 and 2 senders coding schemes
- IEEE 802.11 Wireless LAN
    - Types: 802.11a, 802.11b 802.11g, 802.11n
    - Architecture
        - Base station: access point
        - Basic service set (cell)
    - Channels and association
    - Passive scanning versus active scanning
- IEEE 802.11 multiple access
    - CSMA/ CA
    - CSMA/CA RTS – CTS
- 802.11 frame
    - Addressing
    - Mobility within same subnet
    - Advanced capabilities
        - Rate adaptation
        - Power management
- 802.15 personal area network

5. Security in computer networks
- Network security
    - Confidentiality
    - Message integrity

    - Authentication
    - Access and availability
- Alice, Bob, and Trudy – friends and enemies, and their representation in real life
- Cryptography
    - Terminologies
    - Symmetric key cryptography
        - Caesar cipher
        - DES
            - Operation
        - 3DES
        - AES
    - Public key cryptography
        - Modular arithmetic
        - RSA
            - Public and private key pair
            - Encryption and decryption
            - Implications
- Authentication
    - Digital signatures
    - Message digest
    - Hash function
    - Public key certification
    - Certification authorities
- Secure email
    - PGP
- SSL and TCP/IP
    - Real SSL
        - Handshake
        - Cipher suite
        - Record protocol and format
- Network layer confidentiality
    - VPN
    - IPsec services
    - IPsec protocols
    - Security associations
- Wireless security
    - WEP encryption
    - WEP authentication
    - 802.11 security
- Firewalls
    - Access control lists
    - Packet filtering
    - Application gateways
- Intrusion detection systems