**CS5239 Computer System Performance Analysis**
2004/2005 - Semester 1

**L#01 - Introduction** [Jain91 – chapters 2 & 3]

- Ways of studying a system
- Purpose of evaluation
- Applications of performance evaluation
- Performance evaluation techniques
- Criteria for selecting an evaluation technique
- Applicability of evaluation techniques
- Steps for a performance evaluation study
- Performance evaluation study example
- Performance evaluation metrics

**L#02 - Capacity Planning** [Menasce98 – chapter 5]

- Capacity of a System
- Concept of Adequate Capacity
- Service Level Agreement (SLA)
- Methodology for Capacity Planning
  - Understanding the environment
  - Workload characterization
  - Workload forecasting
  - Performance modeling and prediction
  - Model validation
  - Cost model

**MEASUREMENT TECHNIQUES AND TOOLS**

**L#03 - Workload - Selection, Characterization and Forecasting**

[Jain91 – chapters 4-6]

- Definition
- Types of workload
- Workload selection
- Representativeness of workload model
- Workload characterisation
- Workload forecasting

**L#04 - Instrumentation and Representation of Measurement Data**

- Instrumentation [Jain91 – chapters 7 & 8]
  - Introduction
  - Hardware Monitors
  - Software Monitors
  - Program Execution Monitors
  - Accounting Systems
  - Log Generators
- Representation of Measurement Data [Jain91 –chapters 10 & 12]
  - Gantt Charts
  - Kiviat Graphs
- Summarizing Measured Data
  - Quantile-quantile plots
  - Confidence Interval

**L#05 – BASICS OF COMPUTER SIMULATION** [Law & Kelton – Chapter 1]

- The Nature of Simulation
- Systems, Models, and Simulation

- Discrete-Event Simulation
- Simulation of a Single-Server Queuing System
- Alternative Approaches to Modeling and Coding Simulations
- Steps in a Sound Simulation Study
- Other Types of Simulation
- Advantages, Disadvantages, and Pitfalls of Simulation

## ANALYTIC MODELING TECHNIQUES

### L#06 - Analytical Models and Introduction to Queuing Theory

[Lazowska84 – chapter 2, Jain91 – chapter 30]

- Introduction
- Stochastic Processes
- Basic Components of a Queue
- Kendall Notation
- Rules for all Queues

### L#07 - Operational Analysis [Jain91 – chapter 33, Lazowska84 – chapters 3 & 5]

- Operational Laws
- Utilization Law
- Forced Flow Law
- Little's Law Revisited
- General Response Time Law
- Interactive Response Time Law
- Performance Bounds
  - Asymptotic Bounds
  - Balanced System Bounds
  - Example: Bottleneck Analysis and Modification Analysis

### L#08 - Analysis of a Single Queue [Jain91 – chapter 31]

- General Birth-Death Process Queuing Model
- M/M/1 Queuing System
- M/M/m Queuing System
- M/M/m/B Queuing System

### L#9 - Analysis of Queuing Networks [Jain91 – chapters 32, 34 & 36]

- Queuing Networks
- Product Form Queuing Network
- Queuing Network Analysis
  - Mean Values in Open Queuing Network
  - Analysis of Closed Queuing Network
- Hierarchical Decomposition of Large Queuing Networks
- Multiple Job Classes
  - Why?
  - Open Systems
  - Closed Systems
  - Mixed (open and closed) Systems

### L#10 – Analysis of Queuing Networks

- Why?
- Open Systems
- Closed Systems
- Mixed (open and closed) Systems
- Examples

**L#11 – Principles of Scalable Performance**

- Argument against the Merit of Parallelism
- Performance Metrics
  - Average Program Parallelism
  - Execution Rates
  - Harmonic Mean Performance
  - Efficiency, Redundancy, Utilization and Quality of Computation
- Applications / Algorithms
  - Application Models
  - Scalability of Parallel Algorithms
- Speedup Performance Laws
  - Fixed Workload – Amdahl's Law (1967)
  - Scaled Problems – Gustafson's Law (1987)
  - Memory-Bounded Speedup – Sun & Ni (1993)
- Scalability Analysis and Approaches
- Summary

**CASE STUDIES**

**L#12 - Performance of Client-Server Architectures** [Menasce94 – chapter 7]

**L#13 - WWW Performance Modeling** [Menasce98 – chapter 10]

- Architecture of WWW
- Server-Side Model
- Client-Side Model with Proxy Cache (Intranet Model)

**CONCLUSION**