L00 - Overview
- What, why & how
- Learning objective
- What we cover
- Module assessment
- Course schedule & webpage
- Resources

L01 - Introduction [Jain91 - chapters 2]
- What
- Some goals
- Applications
- Performance evaluation techniques
- Criteria for selecting an evaluation technique
- Applicability of evaluation techniques
- Why performance modeling
- Steps for a performance evaluation study
- Performance evaluation study example
- Summary

CAPACITY PLANNING
L02 - Capacity Planning [Menasce98 - chapter 5]
- What is Capacity Planning
- 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
- Summary

PERFORMANCE MEASUREMENT
L03 Performance Metrics [Jain91 - chapter 3, Lilja - chapter 2]
- What is a Performance Metric?
- Why Performance Metrics?
- Characteristics of Good Metrics
- Standard Processor and System Metrics
- Other Metrics
- Cost/performance Ratio
- Summary

L04 - Workload - Selection, Characterization and Forecasting [Jain91 - chapters 4-6]
- Definition
- Types of Workload
• Workload Selection
• Representativeness of Workload Model
• Workload Characterisation
• Workload Forecasting
• Summary

L05 - 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]
  • Representation
    ▪ Gantt Charts
    ▪ Kiviat Graphs
  • Summarizing Measured Data
    ▪ Quantile-quantile plots
    ▪ Confidence Interval
• Summary

OPERATIONAL ANALYSIS AND ANALYTIC MODELS
L06 - Queuing Theory Terminology [Lazowska84 – chapter 2, Jain91 – chapter 30]
• Introduction to Queuing Theory
  • Basic Components of a Queue
  • Kendall Notation
  • Rules for all Queues
  • Little’s Law
• Analytic Models
  • Modeling Cycle
  • Stochastic Processes
• Summary

L07 - 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
  ▪ Examples: Bottleneck Analysis and Modification Analysis
• Summary

L08 - Analysis of a Single Queue [Jain91 – chapter 31]
• Analytic Models
• General Birth-Death Process Queuing Model
• M/M/1 Queuing System
• M/M/m Queuing System
• M/M/m/B Queuing System
Summary

**L09 - 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
- Summary

**SCALABLE PERFORMANCE**

**L10 - Principles of Scalable Performance** [Hwang93 – chapter 3]
- Argument against the Merit of Parallelism
- Performance Metrics
  - Average Program Parallelism
  - Execution Rates
  - Speedup and Efficiency
- Applications / Algorithms
  - Application Models
  - Scalability of Parallel Algorithms
- Speedup Performance Laws
  - Fixed Workload – Amdahl’s Law (1967)
  - Memory-Bounded Speedup – Sun & Ni (1993)
- Summary

**CASE STUDY**

**L11 - Performance of Client-Server Architectures and Peer-Assisted File Distribution**
- Client Server Architectures [Menasce94 – chapter 7]
  - Problem
  - Performance Considerations
  - Hierarchical Model
    - Higher-level Birth-Death sub-model
    - Lower-level CS sub-model
  - Summary
- Peer-Assisted File Distribution
  - Motivation
  - Challenges
  - Objectives
  - Measurement Analysis
  - General Modeling Approach
  - Model Applications
  - Summary

**L12 - Time-Energy Performance of Heterogeneous Systems**
- Motivation
- Problem
- Challenges
- Objectives
- Measurement-driven Model
  - Core Model
  - Model Extensions
- Model Applications
- Summary

L13 - CONCLUSION

REFERENCES

Homework
1. Performance Metrics
2. Workload and Representation of Measurement Data
3. Operational Analysis
4. Queuing Theory

Assignments
1. Performance Metrics and Measurement; Perf Linux Profiling
2. Operational Analysis and Queuing Models & Analysis