

The Hebrew University of Jerusalem

Syllabus

Workshop In Communication Networks - 67613

Last update 03-03-2025

HU Credits: 5

Degree/Cycle: 2nd degree (Master)

Responsible Department: Computer Sciences

Academic year: 0

Semester: 2nd Semester

Teaching Languages: English and Hebrew

Campus: E. Safra

Course/Module Coordinator: Gil Bloch

Coordinator Email: gil@nvidia.com

Coordinator Office Hours: Coordinate in advance

Teaching Staff:

Mr. Gil Bloch

Course/Module description:

Network-bound applications such as algo-trading, artificial intelligence, live video streams and supercomputing, require specialized mechanisms in the operating system as well as the application itself. This course deals with the unique characteristics of high-performance (low-latency and high-bandwidth) communication and smart network devices, supporting offload from the CPU to the NICs and switches. The course will present and practice the fundamentals of user memory management, message coordination protocols and congestion avoidance algorithms, as well as teach how to avoid common communication bottlenecks, maximize network performance and achieve maximal utilization of the underlying physical network.

Course/Module aims:

The course will present and exercise principles and methods for high-performance communication and the efficient use of network resources.

Learning outcomes - On successful completion of this module, students should be able to:

See course aims

Attendance requirements(%):

100

Teaching arrangement and method of instruction: Lectures and labs

Course/Module Content:

1. Network Benchmarking: latency, bandwidth and throughput.
2. Berkeley Sockets
3. OS adjustments for high rate of communication
4. Infiniband standard and Verbs API
5. Memory management, registration and ODP
6. Infiniband operations: Sends, RDMA and atomic operations
7. Coordination protocols: Eager vs. Rendezvous
8. Advanced offload capabilities: CoreDirect, PeerDirect & GPU-Direct
9. Algorithms for detecting and handling congestion
10. QoS in IB & RoCE
11. Network patterns for scalability.
12. Distributed AI training techniques and the requirements from the interconnect.

Required Reading:

N/A

Additional Reading Material:

- 1) *InfiniBand Network Architecture*, Tom Shanley
- 2) *Attaining High Performance Communications: A Vertical Approach*, Ada Gavrilovska

Grading Scheme:

Active Participation / Team Assignment 10 %

Submission assignments during the semester: Exercises / Essays / Audits / Reports / Forum / Simulation / others 90 %

Additional information:

Grades are based on programming exercises, and one final programming project.