



Kinematics, dynamics, and control of robots (036026) Spring 2025

Lecturer: Assoc. Prof. Yizhar Or, izi@technion.ac.il, office at Kahn Building 407. Office hours by Zoom on Wednesday 9:30-10:30 in this [LINK](#). Please notify in advance by email on your intention to attend

Teaching Assistant: Zvi Chapnik, zvic@campus.technion.ac.il, office at Lady Davis Building 343. Office hours on Wednesday 13:30-14:30 at the office. Please notify in advance by email on your intention to attend

Lectures on Tuesday 12:30-14:30, Tutorials on Tuesday 14:30-15:30, in room 430, Lady Davis Building.

Workshop hours: on Tuesday 15:30-16:30 (dates will be announced)

Curriculum

Part A - Robot kinematics (brief review of serial robot, parts 1-5):

1. Rigid body kinematics, Homogenous transformation matrix.
2. Direct and inverse kinematics of robot manipulators.
3. The Jacobian matrix – velocity and force transformation.
4. Motion in different coordinate systems, Singularities.
5. Serial robot statics.
6. Parallel robot – inverse kinematics and Jacobian.

Part B – Robot dynamics (serial robots):

7. Lagrange equations – review.
8. Dynamics of serial manipulator - Lagrange formulation.
9. Dynamics of serial manipulator - Newton-Euler formulation.

Part C – Control of serial robots:

10. Stability in non-linear systems – Lyapunov stability.
11. Control by Inverse Dynamics.
12. PD control. PID.
13. Min-Max control for uncertain systems.
14. Adaptive control.

Literature

- W Spong & M. Vidyasgar, "Robot Dynamics and Control", John Wiley & Sons, 1989.
- Asada & Slotine, "Robot Analysis and Control", Wiley Interscience, 1986.
- R. Murray, Z Li & S. Sastry, "A mathematical introduction to robotic manipulation", CRC Press, 1994
- J. Craig, "Introduction to Robotics", Addison-Wesley, 1986.
- Tsai, L.W., "Robot analysis : the mechanics of serial and parallel manipulators", Wiley 1999.
- "Modern Robotics" – Prof. Kevin Lynch's book and online course, see [LINK](#).

Pre-requisite courses: Introduction to robotics, Control theory

Grading policy:

Mandatory homework assignment, submission in pairs only– **50%**.

Oral defense on submitted assignments may be required and weighted in grades.

Final exam **50%**, 21/7/2025 session A, 20/8/2025 session B

Minimum required exam grade is **50**, below which the final grade = exam grade

Reserve duty – MILUIM: Students who are expected to be called to service during the semester, please inform us and we will figure out special accommodations and personal guidance.



Schedule plan for the course – spring 2025

(Dates and topics are tentative and may be subject to changes)

No.	Date	Topic	Homework & comments
1	1/4	Rigid body kinematics. Serial robots - forward and inverse kinematics	HW#1 released
2	8/4	Jacobian, statics & singularity in serial robots [Supplementary recording (2021) - path planning]	
15/4 – Passover Holiday– No school			
3	22/4	Kinematics of parallel robots	
4	29/4	Jacobian, Statics and singularity in parallel robots	HW #1 submission HW#2 released
5	6/5	Robot dynamics – Newton-Euler equations	
13/5 – Entrepreneurship day – no school			
6	20/5	Dynamics – Lagrange’s equations	
7	27/5	Lagrange’s equations for serial robot dynamics	HW #2 submission HW #3 released
8	3/6	Introduction to robot control Tutorial class – linear state feedback, PID control	
9	10/6	“Inverse dynamics” control, Lyapunov stability + function	
10	17/6	Stability analysis using Lyapunov functions – cont. PD and PID control for serial robots (Tutorial: PD+PID+inverse dynamics control examples)	HW #3 submission HW #4 released (due by 13/7)
11	24/6	Min-Max control for systems with uncertainty and serial robots	
12	1/7	Adaptive control	
13	8/7	Supplementary material, review for exam, lab tour.	
		Final Exams: 21/7 session A, 20/8 session B	

***HW submission deadlines of homework assignments will be strictly enforced! 3 points will be deducted from the HW grade for every day of delayed submission, up to 5 days allowed.