

**National University of Singapore
B Tech Programme
Faculty of Engineering**

TM 4245: Robotics

Introduction, Spatial Descriptions and Transformations, Manipulator Forward and Inverse Kinematics, Mechanics of Robot Motion, Robot Dynamics, Static Forces and Torques, Trajectory Planning, Robot Control

<i>Contents</i>	Hours (lecture + tutorial)
1. Introduction, Spatial Descriptions and Transformations Robot definition. Robot classification. Robotics system components. Notations. Position definitions. Coordinate frames. Different orientation descriptions. Free vectors. Translations rotations and relative motion. Homogeneous transformations.	5
2. Manipulator Forward and Inverse Kinematics Link coordinate frames. Denavit-Hartenberg convention. Joint and end-effector Cartesian space. Forward kinematics transformations of position. Inverse kinematics of position. Solvability. Trigonometric equations. Closed-Form Solutions. Workspace.	6
3. Mechanics of Robot Motion Translational and rotational velocities. Velocity Transformations. The Manipulator Jacobian. Forward and inverse kinematics of velocity. Singularities of robot motion.	6
4. Static Forces and Compliance Transformations of static forces and moments. Joint and End-Effector force/torque transformations.	3
5. Robot Dynamics and Trajectory Planning Lagrangian formulation. Model properties. Newton-Euler equations of motion. Simulations. Joint-based motion planning. Cartesian-based path planning.	10
6. Robot Control Independent joint control. Feedforward control. Inverse dynamics control. Robot controller architectures. Implementation problems.	9
<i>Total</i>	39

Assessment

2 Quizzes (30 %)

Final Exam (70%)

(All quizzes and final examination are open book/notes.)

References

1. Sciavicco L. and Siciliano B., *Modeling and Control of Robot Manipulators*. Second Edition (ISBN 1-85233-221-2), Springer Verlag, London, 2000. (Recommended for purchase)
2. Fu K.S., Gonzalez R.C., and Lee C.S.G. *Robotics: Control, Sensing, Vision and Intelligence*. McGraw-Hill, NY, 1987. (Recommended for purchase)
3. Sciavicco L. and Siciliano B., *Modeling and Control of Robot Manipulators*. McGraw Hill, 1996.
4. Craig, J.J., *Introduction to Robotics, Mechanics, and Control*. 2nd Edition. Addison Wesley, MA, 1989. (3rd Edition, if available)
5. Spong, M.W. and Vidyasagar, M., *Robot Dynamics and Control*, Wiley, New York, 1989.
6. Paul, Richard P., *Robot Manipulators : Mathematics, Programming, and Control : the Computer Control of Robot Manipulators*, MIT Press, Cambridge, Mass., 1981.
7. Lewis F.L., Abdallah C.T., and Dawson D.M., *Control of Robot Manipulators*, Maxwell Macmillan International, 1993.

References are available in Recommended Book Room (Central Library)

Lecturers:

Topics 1-4:

Dr. Marcelo H. Ang Jr. E3A-04-09 6516-2555 mpeangh@nus.edu.sg

Topics 5-6:

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Please refer to this webpage regularly.