# ADVANCED ROBOTICS

**PROF. ASHISH DUTTA**
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**PRE-REQUISITES :** Basic Mathematics : matrices, differential equations

**INTENDED AUDIENCE :** Students (UG 3rd/4th year in Mechanical/Electrical/Computer Science), Teachers of engineering colleges, Industry professorial

**INDUSTRY SUPPORT :** All Manufacturing companies (TATA motors,Mahindra,Maruti, Hyundai,GE,GM,etc),IT companies (TCS, Infosys, etc),process industries using robotics

**COURSE OUTLINE :**

The course is intended as a second level course for students, teachers and industry personal interested in learning the advanced concepts in robotics, as required in the design and control of robotic systems. This course is not intended as a basic course for learning robotics. The course starts with an introduction to robotics, linkages and workspaces, transformations, kinematics, trajectory planning and dynamics. Next, singular value decomposition is introduced to explain the concept of manipulation ability that is followed by the basics of linear control methods. The course also introduces advanced topics like modeling and analysis of multi-finger grasping, legged robots, their design and optimization with real world applications.

**ABOUT INSTRUCTOR :**

Prof. Ashish Dutta obtained his PhD in Systems Engineering from Akita University, Japan, M.Tech from Jadavpur University and B.Tech from NIT Calicut. From 1994 to 2000 he was with the Bhabha Atomic Research Center, Mumbai where he worked on telemanipulator design and control for nuclear applications. Since 2002 he is with the department of mechanical engineering at IIT Kanpur, India. He was also a visiting professor in Nagoya University, Japan in 2006 and is currently a visiting professor at Kyushu Institute of Technology, Japan (2015 - ). His research interests are in the areas of humanoid robotics,motion planning in 3D, intelligent control systems and rehabilitation engineering.Prof. Dutta has also served as advisory board member of ISRO Chandrayan II Lunar mission (2009), member of Task force on AI of the Ministry of Commerce and Industry (2017), Secretary of The Robotics Society of India (2011-2017), member Bureau of Indian Standards (Robotics Section), Chairman India-South Korea robotics working group (2013-) , Chairman IEEE Robotics and Automation section (UP, UK section), etc.

**COURSE PLAN :**

**Week 1:** Introduction, transformations
**Week 2:** DH Parameters
**Week 3:** Forward and Inverse Kinematics, redundancy resolution
**Week 4:** Velocity kinematics and Jacobian
**Week 5:** Singular value decomposition, singularity and manipulation ability
**Week 6:** Trajectory planning , dynamics
**Week 7:** Sensors and actuators as used in robotics
**Week 8:** Basics of linear control – PD, PID controller, model based control, stability
**Week 9:** Multi finger grasping – form, force closures, grasp matrix
**Week 10:** Locomotion – active and passive walkers, concepts of balance
**Week 11:** Biped Gait and Balance using ZMP, kinematics and dynamic modeling of walk
**Week 12:** Design and Optimization of legged mechanisms