WELCOME

21AIE201-INTRODUCTION TO ROBOTICS

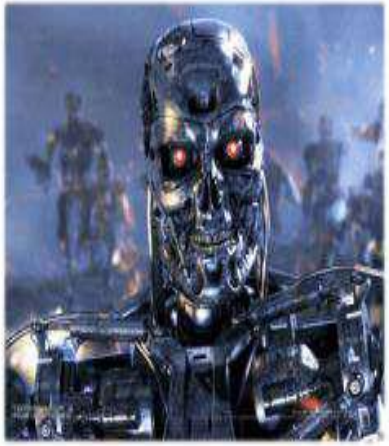
Dr. Golak Bihari Mahanta

What’s different about engineers and scientists?

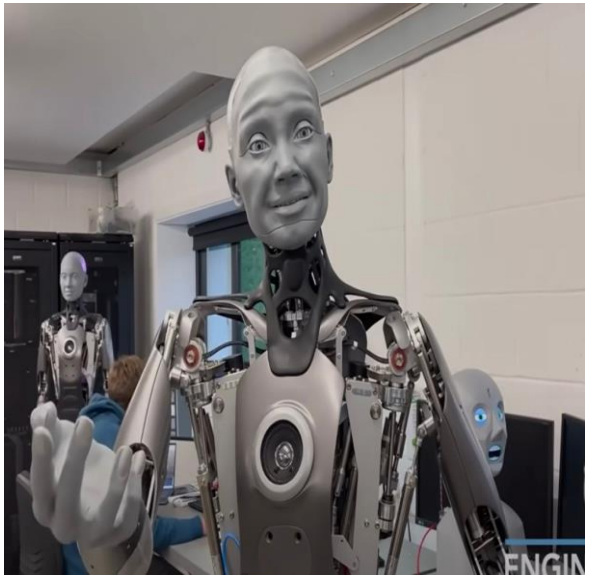
What do engineers do?

- Engineers design creative solutions to all sorts of problems
- Engineers are people who use math, science, and technology to solve problems
- Work with other people on a team to develop new products or systems
- Make things work better
- Learn new things and always improve
- Planning and managing projects

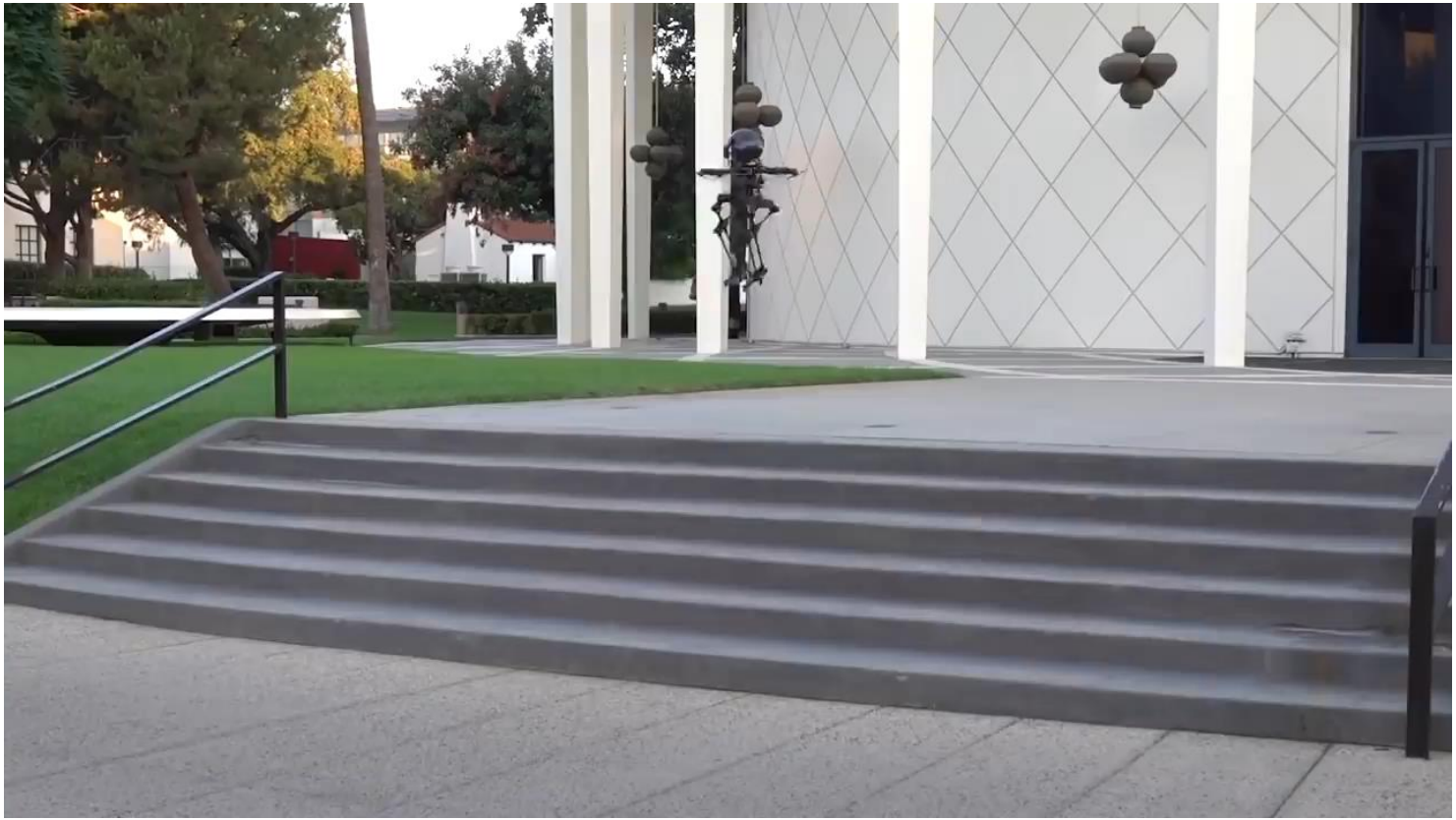
What do you think of when you hear the word “robot”?



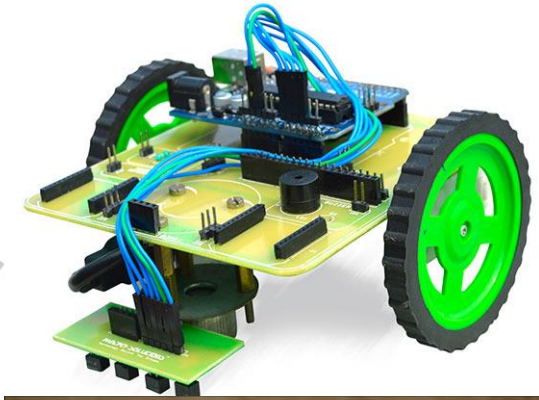
World’s Most Advanced, Most Realistic Humanoid Robot

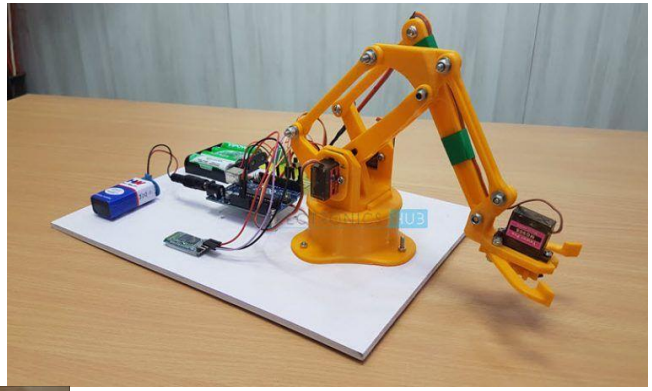


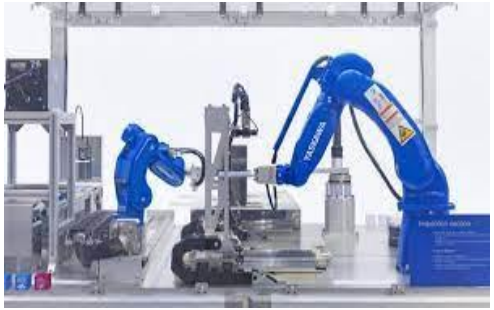
Some of the World’s Most Advanced Robots

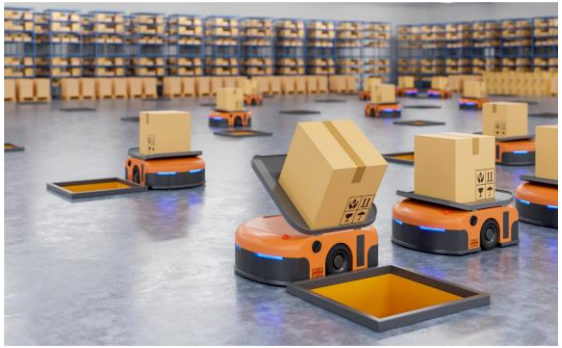


What do you think of when you hear the word “robot”?









What do these two things have in common?

Personal Computer

Personal Phone

Hardware modules enable various combinations

Personal Computer

Personal Phone

Operating System + Application

Personal Computer

Personal Phone

Changes brought by the software platform

[The first commercially available mobile phone (?) In 1983 Motorola DynaTAC 8000 and developer Martin Cooper, and the evolution of mobile phone]

What about

Robotics Field?

What about robots? Flood of various Robot OS!

Major robot operating system

Major robot operating system

History repeats itself! Are you ready for it?

	PC (Personal Computer)	PP (Personal Phone)	PR (Personal Robot)
User			
Service			
Operating System			
Hardware			

ALL OF YOU MUST BE HAVE SOME QUERIES:

- What skills do you need to work with robots?
- Which subjects should you study?
- How can you start your dream career in robotics?

What type of person works in robotics?

- Robotics engineers are **learners.**
- Robotics engineers are **masters-of-all-trades.**
- Robotics engineers know a little bit about everything (at least, everything important to robotics).
- They are the bridge between mechanical engineering, electrical engineering, Electronics, computer science**.**

How to get started in robotics

- Robotics is not a straightforward career choice. It is a truly interdisciplinary career. This makes it different from many traditional jobs.
- You want to be a doctor? Study medicine.
- You want to build bridges? Study civil engineering.
- You want to work with robots? Well… you could study electronics, computer science, biotechnology, manufacturing, cognitive science…
- … there are loads of routes to a job in robotics!

Core subjects for students

At the most basic level there are 2 core subjects which you need to get started in robotics:

Mathematics — This is a must. You don't have to be **John Nash** — the famous American mathematician (A Beautiful Mind) — but a good grasp of algebra and geometry are essential to all of the subjects which make up robotics.

Physics (or another science) — It is important to have a solid understanding of science if you want to work in any branch of engineering. Physics is particularly useful because it provides foundational knowledge in **energy, electrical circuits, mechanics, material science,** and other key topics for robotics.

Useful subjects for students

Computing and Programming — Programming is important for robotics so subjects like Computer Science and Information Systems are a great choice.

Design and Technology —Subjects that can boost the practical side of engineering include Product Design, Graphic Communication, Technological Studies and Manufacturing. (AutoCAD, Solidworks, Blender)

Specific Engineering Disciplines —Subjects in specific engineering disciplines such as Automotive, Bioengineering, Electronics, Mechatronics and Mechanical engineering. All of these can be beneficial for aspiring roboticists.

"The Body" - Mechanical Engineering - This branch of engineering looks at the physical systems which make up a robot. Subtopics like mechanics, materials engineering and manufacturing are core to industrial robotics. Often, mechanical engineering courses will tend to be focused mostly on physical design and actuation.

"The Nervous System" - **Electrical and Electronic Engineering** - This branch of engineering gives you the basics of electronics, embedded systems, low-level programming, and control theory.

"The Brain" - **Computer Science** - Artificial Intelligence and Software Design

10 Essential Skills All Good Roboticists Have

1. Systems Thinking
2. The Programming Mindset
3. Active Learning
4. Mathematics
5. Science or other Applied Mathematics
6. Judgment and Decision Making
7. Good Communication
8. Technology Design
9. Complex Problem Solving
10. Persistence

Career Opportunities in Robotics

- Space Research
- Medical
- Private Organizations
- Entertainment
- TATA
- DRDO
- BARC
- DiFACTO Robotics and Automation
- BHEL
- NASA
- Tech Mahindra Ltd
- Kuka Robotics
- ISRO etc.

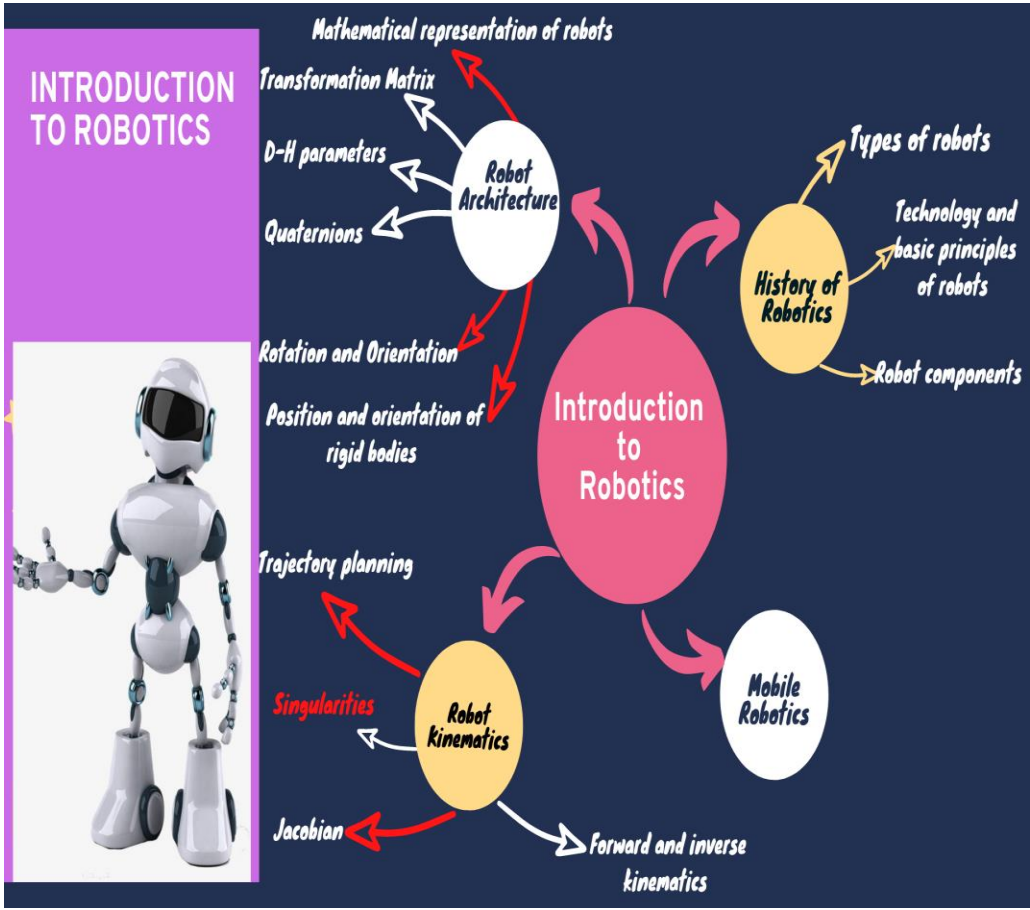
Course Syllabus

Introduction to robots: History – Types of robots – Technology and basic principles of robots and its components

Robot Architecture: Mathematical representation of robots – Position and orientation of rigid bodies – Rotation and Orientation – Quaternions and other rotation representations– Transformation Matrix – D-H parameters – Forward and inverse kinematics of robot manipulators

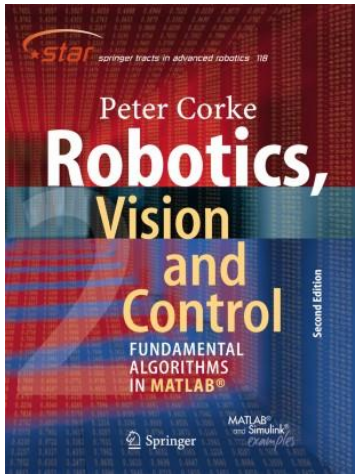
Jacobian – Singularities- Trajectory planning

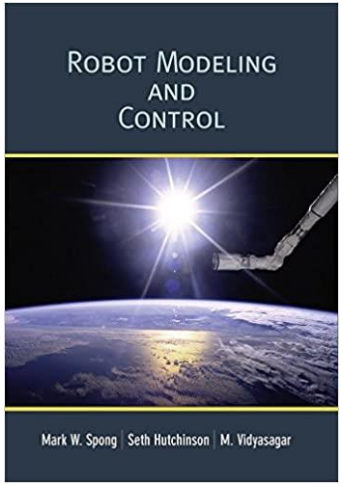
Introduction to mobile robot navigation.

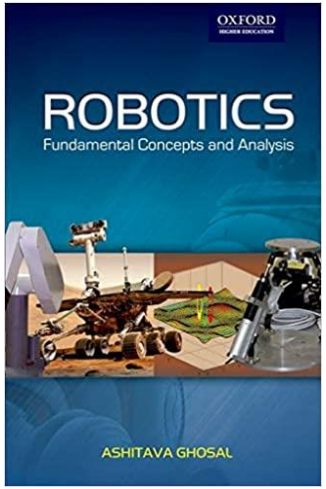


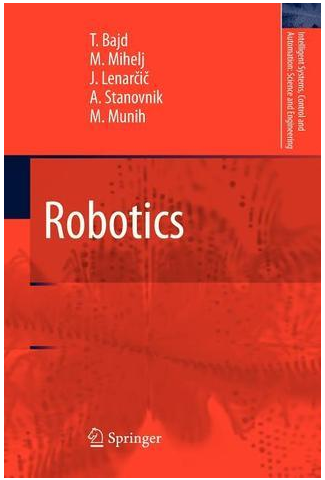
Text Book / Reference Books

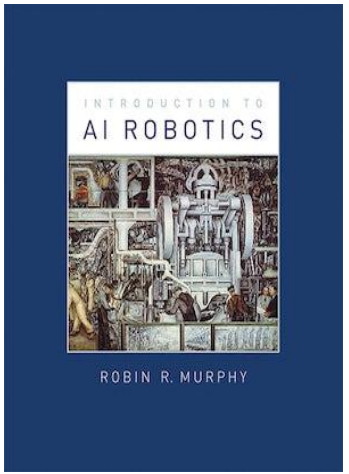
1. 'Robotics, Vision & Control', P. Corke, 2nd edition, Springer, 2011
2. 'Robot Modeling and Control', M.W. Spong, S. Hutchinson and M. Vidyasagar, Wiley, 2006
3. 'Robotics: Fundamental Concepts & Analysis', A. Ghosal, Oxford University Press, Ninth Edition, 2006
4. 'Introduction to Robotics', T. Bajd, M. Mihelj and M. Munih, Springer Briefs in Applied Sciences and Technology, 2013
5. 'Introduction to AI Robotics, Robin Murphy, MIT Press, 2000











Evaluation and Grading

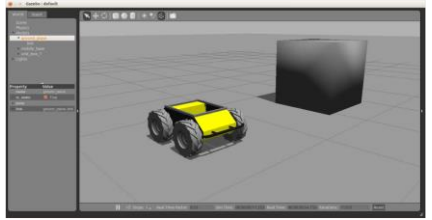
Internal			External	Total
Continuous Assessment	**Weightage**			
Assignment 1 (10)	**10%**	**70%**	**Term Project (30%)**	**Internal + Term Project =100%**
Assignment 2 (10)	**10%**			
Assignment 3 (10)	**10%**			
Quiz 1 (10)	**10%**			
Quiz 2 (10)	**10%**			
Midterm (20)	**20%**			

HOW TO BUILD YOUR OWN ROBOT?

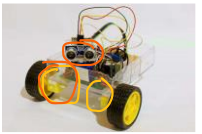
1. **Robot designing**

2. **3D Modeling**

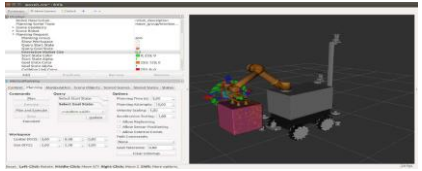
3. **Simulation**



4. **Prototyping**



5. **Robot Software**



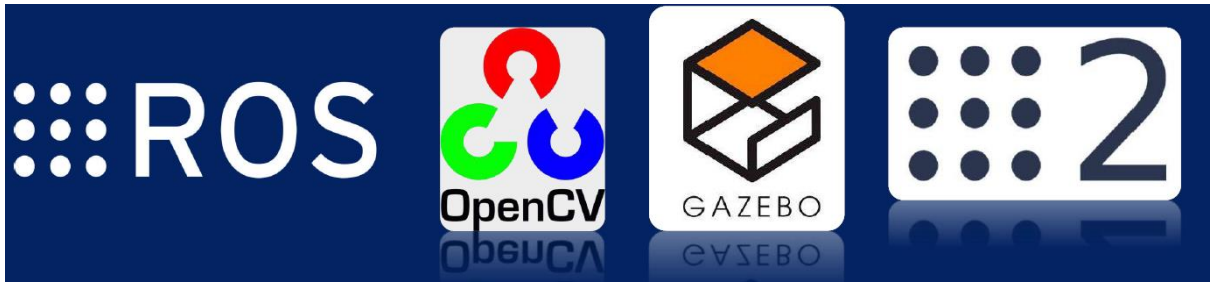
HOW TO PROGRAM A ROBOT?

Robot programming is programming the PC/SBC/microcontroller/PLC inside a robot for performing a specific application using actuators and feedback from various sensors.

SOFTWARE FRAMEWORKS FOR PROGRAMMING ROBOTS

Programming languages: C/C++, Python, Java, C#, SCADA, RAPID programming

Software frameworks: ROS, OpenCV, PCL, Gazebo, Open Rave, Webots, V-REP



SIMULATION TOOL

1. **RoboAnalyze**r,
2. ADAMS,
3. Simulink
4. V-Rep
5. **RoboDK**
6. **GAZEBO**
7. **RIVZ**
8. **WeBots**

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