

## Recommended Learning for CAM Members

Recommended system: Ubuntu 20.04 + ROS Noetic. (Using [VM](#) or [WSL](#) is ok but a Standalone or Dual Booted system is recommended for a better learning experience)

### 1. Programming

Codecademy is a great place to get free programming lessons. You will need to open an account.

- a. C/C++: <https://www.codecademy.com/learn/learn-c-plus-plus>
- b. Python: <https://www.codecademy.com/learn/learn-python-3>
- c. Command-line: <https://www.codecademy.com/learn/learn-the-command-line>
- d. CMake Tutorials: <https://cmake.org/cmake/help/latest/guide/tutorial/index.html>
- e. Git: <https://www.codecademy.com/learn/learn-git>
- f. C++ Coding Guidelines and Best Practices: [MISRA C](#) and [MISRA C++](#), and [Google](#)
- g. Python Programming Guidelines and Best Practices: [PyGuide](#)

### 2. ROS

- a. ROS basics: <http://wiki.ros.org/ROS/Tutorials>
- b. RViz: <http://wiki.ros.org/rviz/Tutorials>
- c. ROS-Industrial (great for manipulators): <http://wiki.ros.org/Industrial/Tutorials>
- d. ROS-URDF Tutorials: <http://wiki.ros.org/urdf/Tutorials>
- e. Although we highly recommend the free tutorials, some people have found this paid class useful: <https://www.theconstructsim.com/>

### 3. Math for Robotics

- a. Math Fundamentals for Robotics: (<https://www.cs.cmu.edu/~me/811/>)
- b. Modern Robotics by Northwestern ([YouTube Link](#)). There is a coursera version for this course as well.
- c. Basic Paid Courses by ConstructSim: ([Basic Math](#)), ([Robot Dynamics and Control](#)), and ([Arm Kinematics](#)). We recommend referring to open-source material but some of our group members found these paid courses to be helpful
- d. Motion Planning Books: Introduction to Robotics by John J. Craig ([Link](#)), and Robot Modeling and Control by M. W. Spong ([Link](#))

### 4. Libraries and Tools for Linear Algebra and Basic Optimization:

- a. Eigen: <https://eigen.tuxfamily.org/dox/>
- b. Numpy: <https://numpy.org/>
- c. NLOPT: <https://nlopt.readthedocs.io/en/latest/>
- d. Scipy: <https://scipy.org/>

### 5. Motion planning

We highly recommend doing the Math for Robotics section and reading some books/papers (e.g., [Planning Algorithms Book by Steven M. LaValle](#)) before starting this.

- a. MoveIt: [https://ros-planning.github.io/moveit\\_tutorials/](https://ros-planning.github.io/moveit_tutorials/)
- b. OMPL: <https://ompl.kavrakilab.org/tutorials.html>

- c. TOPPRA (We use this for Trajectory Planning only. This is more advanced and can be skipped initially): <https://github.com/hungpham2511/toppra>
- 6. Computer Vision
  - a. OpenCV: [https://docs.opencv.org/master/d9/df8/tutorial\\_root.html](https://docs.opencv.org/master/d9/df8/tutorial_root.html)
  - b. PCL: <http://www.pointclouds.org/documentation/tutorials/>
  - c. Open3D: <http://www.open3d.org/>
- 7. Machine Learning Tools and Libraries
  - a. PyTorch: <https://pytorch.org/>
  - b. Tensor flow: <https://www.tensorflow.org/tutorials>
  - c. Scikit-learn: <https://scikit-learn.org/stable/tutorial/index.html>
- 8. Physics Simulator
  - a. Gazebo: <http://gazebo.org/tutorials>
  - b. MuJoCo: <https://mujoco.org/>
  - c. WeBots: <https://cyberbotics.com/doc/guide/index>