

1. Define the Lab Purpose

Before procuring equipment, define the **type of robotics lab**:

Examples:

- **Educational / Training Lab:** For students to learn robotics concepts, coding, and mechanical design.
- **Research Lab:** Advanced robotics research (AI, control systems, humanoids, swarm robotics).
- **Industrial / Applied Robotics Lab:** Testing automation, industrial manipulators, and robotics applications.

Your equipment selection depends on this focus.

2. Physical Infrastructure

◆ Space Requirements

- Minimum **200–500 sq. ft.** for a small lab, more for industrial robots.
- Workbenches and tables for assembly and electronics.
- Shelves/racks for storing components and tools.
- **Flooring:** Anti-static mats for electronics assembly.
- **Lighting:** Bright, uniform LED lighting.
- **Power supply:** Sufficient outlets (220V/50Hz), UPS for sensitive equipment.
- **Networking:** High-speed internet, Wi-Fi, LAN for connected robotics.

◆ Safety Infrastructure

- Fire extinguishers (Class C for electronics)

- First aid kits
 - Emergency stop buttons for robot test zones
 - Safety barriers or cages for large robots
 - Ventilation and fume extraction for soldering
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3. Robotics Hardware Equipment

3.1 Microcontrollers & Development Boards

- **Arduino Uno / Mega / Nano**
- **Raspberry Pi** (Pi 4, Pi Zero W)
- **ESP32 / ESP8266** (IoT-enabled)
- **STM32 / NXP / Teensy boards** for advanced research

3.2 Sensors

- Ultrasonic distance sensors (HC-SR04)
- IR sensors and line-following sensors
- Light sensors (LDR)
- Temperature and humidity sensors
- Gyroscope and accelerometers (MPU6050)
- Force/pressure sensors
- Camera modules (Raspberry Pi camera, OpenMV, Intel RealSense)
- LiDAR (Hokuyo, RPLidar) for mapping/SLAM

3.3 Actuators

- DC motors with encoders

- Servo motors (SG90, MG996R, industrial-grade)
- Stepper motors (NEMA17, NEMA23)
- Motor drivers (L298N, TB6612, DRV8825)
- Linear actuators for manipulators

3.4 Robot Kits

- Line-following robot kits
- Humanoid robot kits (e.g., Robotis Bioloid, Tinkerbots)
- Robotic arm kits (Dobot Magician, OWI, Arduino-based arms)
- Mobile robot chassis kits

3.5 Industrial Robots (for advanced labs)

- Collaborative robots (UR3/UR5/UR10)
 - 6-axis manipulators (Kuka, ABB, Fanuc)
 - End effectors (grippers, suction cups, welding tools)
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4. Software & Simulation Tools

Programming Tools

- Arduino IDE
- Python (with libraries like OpenCV, TensorFlow, PyTorch, ROS)
- MATLAB/Simulink (for control and simulation)
- C/C++ compilers

Simulation & Design

- **Gazebo / ROS** – robot simulation

- **V-REP / CoppeliaSim**
- **SolidWorks / Fusion 360** – CAD for robot parts
- **AutoDesk Inventor** – 3D design

AI & Vision Software

- OpenCV (computer vision)
 - TensorFlow / PyTorch (machine learning for robots)
 - ROS (Robot Operating System) for middleware
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5. Electronics & Mechanical Tools

Electronics

- Multimeters, oscilloscopes, logic analyzers
- Soldering stations and desoldering tools
- Power supplies (variable DC)
- Breadboards and jumper wires
- PCB prototyping kits

Mechanical

- 3D printer (FDM / SLA) for custom parts
 - CNC machine (optional for research/industrial labs)
 - Laser cutter (optional)
 - Screwdrivers, pliers, hex keys, wrenches
 - Drill and small hand tools
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6. Connectivity & IoT Equipment

- Wi-Fi routers and switches
 - Bluetooth modules
 - Zigbee / LoRa / IoT modules
 - Cloud servers (optional for IoT robotics research)
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7. Learning & Reference Materials

- Robotics textbooks and manuals
 - Online subscriptions for ROS / AI / robotics courses
 - Technical datasheets for sensors, motors, microcontrollers
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8. Staffing & Roles

Role	Responsibility
Lab Director / PI	Overall management, research guidance
Robotics Engineer	Hardware assembly, sensor integration
Software Engineer	Programming, AI, control algorithms
Technician	Maintenance, troubleshooting
Research Assistant / Students	Experiments, simulations, documentation

9. Safety & Compliance

- Emergency stop switches for test areas

- PPE (gloves, goggles)
 - Fire safety for electronics and chemical-based 3D printing
 - Compliance with Indian electrical safety regulations
 - Insurance for expensive industrial robots
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10. Suggested Lab Tiers & Cost Estimates

● Basic Educational Lab

- Arduino/Raspberry Pi kits
- Small robot kits (line follower, robotic arms)
- Basic sensors and actuators
- Breadboards, multimeters, soldering kit

Cost: ₹2–5 lakh

● Intermediate Research Lab

- Advanced sensors (LiDAR, IMU)
- 3D printer, CNC/laser cutter
- Multiple microcontrollers & robot kits
- Simulation software licenses

Cost: ₹10–25 lakh

● Advanced Industrial / AI Robotics Lab

- Collaborative robots (UR, KUKA, ABB)
- Humanoid / advanced manipulators
- High-end sensors and vision systems

- Full CAD/CAM/ROS infrastructure
Cost: ₹50 lakh – 2 crore+
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11. Example Workflow

1. Design robot parts in CAD
2. 3D print or fabricate components
3. Assemble hardware and integrate electronics
4. Program microcontrollers or ROS nodes
5. Test robot movements, sensors, and algorithms
6. Collect and analyze data
7. Iterate design and optimization