Courses of Study

B.Tech Robotics and Automation

Batch 2024 Onwards

3rd Semester

Department of Mechanical Engineering

Islamic University of Science and Technology Kashmir

Table of Contents

Detailed Course Contents for 3rd Semester

Total Credits = 24 *Total Hours Per Week = 30*

Course Code	Course Title	L	T	P	S	Credits
MEC208C	Mechanics of Deformable Solids	3	1	0	0	4
ELE209C	Electrical Machines and Actuators	3	0	2	0	4
MEC216C	Materials and Processes in Manufacturing	3	0	2	0	4
MEC209C	Complex Variables and Laplace Transform	3	0	0	0	3
MEC215C	Introduction to Robotics and Automation	2	0	0	0	2
MEC217C	Thermal Engineering Principles	2	0	0	0	2
MEC204C	Machine Drawing and Solid Modelling	1	0	4	0	3
CSE207C	Applied Python for Robotics	0	0	4	0	2

Note(s):

A student has to undergo an Internship/Practical Training during vacations following the third semester, which shall be evaluated in the fourth semester. The minimum duration of such internship or training has to be four weeks.

MEC208C	Mechanics of Deformable Solids	3-1-0-0

Course Objectives: This course equips students with the fundamental principles of stress and strain analysis, enabling them to evaluate bending and shear stresses in beams and structural members. They will apply these concepts to design columns and pressure cylinders, ensuring structural integrity under various loading conditions. Through theoretical and practical learning, students will develop the skills to solve real-world engineering problems related to mechanical and structural design.

Course Outcomes: At the end of this course, a student will be able to:

1. Explain concepts of stress and strain.
2. Analyse bending and shear stresses developed in beams.
3. Compute shear stresses developed in shafts.
4. Evaluate the slope and deflection in beams.
5. Design and analyse columns and pressure vessels.

Module I

Concept of Stress and Strain: Concept of stress and strain, Hooke's law, Tensile, compressive and shear stresses, Poisson's ratio, Stress-strain diagram, Elastic constants and their relationships, Volumetric strain, Bars of uniform and varying sections subjected to single and multiple loads, Analysis of bars of composite sections, Concept of thermal stress, Principal plane and principal stress, Transformation of plane stress, Mohr's circle.

Module II

Mechanics of Beams: Shear force, bending moment diagram for cantilever, simply supported, overhanging beam due to point load, uniformly distributed load and uniformly varying load, Theory of pure bending, Bending stress in beams of regular sections, I-section, T-section, Derivation of shear stress distribution in beams of simple sections, Shear stress distribution in beams having I and T sections, shear center and shear flow.

Module III

Deflection of Beams: Relation between deflection, slope, radius of curvature, shear force, bending moment, Slope and deflection of cantilever, and simply supported beams subjected to point load and uniformly distributed load using double integration method, Macaulay's method, and moment-area method, Slope and deflection of propped cantilever and continuous beams using double integration method, Macaulay's method, and moment-area method.

Module IV

Theory of Pure Torsion: Shear stress in terms of torque in a circular shaft, Strength, Stiffness, Torsional rigidity and power transmitted, Torque expression for solid and hollow circular shafts subjected to torsion, Shafts of varying sections subjected to single and multiple torques, Circular shafts in series and parallel, Solid and hollow circular shafts subjected to combined bending and torsion, Composite solid and hollow circular shafts.

Module V

Columns and Pressure Vessels: Members subjected to combined bending and axial loads, Expression for crippling load with different end conditions based on Euler's and Rankine's theories, column subjected to eccentric load. Thin cylindrical and spherical shells subjected to internal pressure, Change in dimensions of thin cylindrical and spherical shells due to internal pressure, Lame's theory on stresses in thick cylinders.

Text Books:

1. I. H. Shames, J. M. Pitarresi, Introduction to Solid Mechanics, Prentice Hall India, 3rd Edition, 2000.
2. S. Timoshenko, Strength of Materials, Part 1: Elementary Theory and Problems, CBS, 3rd Edition, 2021.
3. S. Timoshenko, Strength of Materials, Part 2: Advanced Theory and Problems, CBS, 3rd Edition, 2021.

Reference Books:

1. F. P. Beer, E. R. Johnston, J. T. DeWolf, D. F. Mazurek, Mechanics of Materials, McGraw Hill, 7th Edition, 2014.
2. R. C. Hibbeler, Mechanics of Materials, Pearson, 9th Edition, 2013.
3. E. P. Popov, Mechanics of Materials, Pearson Education India, 2nd Edition, 2015.

Online Resources:

1. Mechanics of Solids by Dr. Priyanka Ghosh (IIT Kanpur), NPTEL Course (https://nptel.ac.in/courses/105104160).

ELE209C Electrical Machines and Actuators 3-0-2-0

Course Objectives: This course introduces electric drives and actuators, covering their principles, performance analysis, and industrial applications. Students will learn to evaluate drive characteristics and integrate them into automation and robotics systems.

Course Outcomes: At the end of this course, a student will be able to:

1. Explain the key concepts and components of electric drives and actuators.
2. Demonstrate an understanding of different types of electric motors and their operational principles.
3. Apply various speed control techniques for DC and AC motors.
4. Analyze the performance of electric drives in terms of torque-speed characteristics.
5. Integrate electric drives and actuators into automated systems for industrial applications.

Module I

Introduction to Electrical Machines and Actuators: Overview of electrical machines and actuators, basic electromagnetism principles (Faraday's law, Lorentz force), classification of AC, DC, and special machines (stepper, servo motors), introduction to actuators (electric, hydraulic, pneumatic), and their key characteristics such as torque, speed, and efficiency in robotics.

Module II

DC Machines and Actuators: Study of DC motors (construction, types: series, shunt, compound, permanent magnet), speed-torque characteristics, and applications in robotics, such as wheeled robots and conveyor systems.

Module II

AC Machines and Actuators: Examination of AC motors (induction and synchronous motors), their working principles, performance curves, and use in automation, such as robotic arms and conveyors.

Module IV

Special Electrical Machines and Actuators: Study of stepper motors (types, step angle, microstepping), brushless DC motors (BLDC), linear induction motors (LIMs), and piezoelectric actuators, focusing on their roles in precision positioning, robotics, drones, and electric vehicles.

Module V

Integration, Control, and Advanced Topics: Discussion on selecting motors and actuators, integration in robotic systems, considerations for power and efficiency, and exploration of emerging technologies like smart actuators, IoT, and wireless control in robotics.

List of Practicals

1. To study various parts of a DC machine and draw sketches of the same.
2. To plot the saturation curve of a DC machine.
3. Starting of the DC motor by using a starter.
4. Speed control of DC series and shunt motor by armature voltage control.

5. Speed control of DC shunt motor by flux or field control.
6. To study the different parts of an Induction motor.
7. To determine the Torque-speed characteristics of a 3-phase Induction motor.
8. Study of V/f control operation of three-phase induction motor drive.
9. Open loop and closed loop control of BLDC motor.

Text Books:

1. G. K. Dubey, "Fundamentals of Electrical Drives", Narosa Publishing House, New Delhi, 2nd edition, 2001.
2. M. H. Rashid, "Power electronics: circuits, devices, and applications", Pearson Education India, 2009.
3. A. Hughes and B. Drury, "Electric Motors and Drives: Fundamentals, Types and Applications", Newnes, 2019

Reference Books:

1. Vedam Subramanyam, Electric Drives Concepts and Applications, Tata McGraw Hill Education Private Limited, 2nd edition, 2011
2. P.S. Bimbhra , "Power Electronics", 4th edition, Khanna Publisher, India, 2018.
3. S.R. Deb and Shanka Deb Robotics Technology and Flexible Automation, 2nd Edition, McGraw Hill Education (India) Private Limited, 2010.

Online Resources:

1. Fundamental of Electric Drives by Prof. S.P Das (IIT Kanpur), NPTEL Course (https://archive.nptel.ac.in/courses/108/104/108104140/).

MEC216C Materials and Processes in Manufacturing 3-0-2-0

Course Objectives: This course will enable students to provide a foundational understanding of engineering materials and manufacturing processes, integrating concepts of material properties, classifications and their application in various manufacturing techniques

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Course Outcomes: At the end of this course, a student will be able to:

1. Identify and classify different types of engineering materials including metals polymers ceramics and composites
2. Describe and differentiate primary manufacturing processes
3. Demonstrate knowledge of subtractive manufacturing processes including machining operations like turning, milling, drilling and grinding and understand the principles of cutting tools and their materials
4. Understand and apply various plastic processing techniques.
5. Evaluate advanced manufacturing processes such as additive manufacturing, nonconventional machining and powder metallurgy.

Module I

Introduction to Engineering Materials: Classification and properties of Engineering materials. (Metals, Alloys, polymers, ceramics). Structure property relationships. Basics of composites and their applications. Introduction to Smart Materials. Advanced ceramics and their applications (biomedical and electronic devices). Nanomaterials and their properties.

Module II

Metals and primary manufacturing processes: Classification and applications of metals and alloys. Heat treatment of metals and alloys. Casting-metal casting processes- patterns and pattern allowances –Sand mold casting –fundamentals – steps and applications. Metal working –elastic and plastic deformation processes -Hot and cold working. Bulk forming processes- forging, rolling, extrusion.

Module III

Metals and subtractive manufacturing processes: Introduction to machining, orthogonal and oblique –tool signature, cutting tool nomenclature and materials. Lathe, milling, drilling and grinding operations. Advanced cutting tool materials and coatings.

Module IV

Plastics and manufacturing processes: Introduction to plastics-classification, properties and applications. Processing of Plastics–Injection molding, blow molding, Transfer molding, compression molding- principles and applications. High performance polymers and their applications.

Module V

Advanced Manufacturing processes: Introduction to non -conventional machining, Abrasive Jet Machining, Ultrasonic machining, Electro Discharge machining. Advanced casting processes (EPC, ceramic shell, vacuum die casting) Introduction to Powder Metallurgy-Definition, procedure,

advantages and applications. Additive manufacturing -3d printing –types and materials.

List of Practicals:

1. Study and identification of different Engineering materials used in manufacturing.
2. Preparation of sand mold for the given engineering part and investigating the mold properties.
3. Fabrication of Pattern for sand molding through conventional and digital manufacturing method.
4. Prepare a single point cutting tool from wood/foam as per given specifications (to check the tool angles).
5. Prepare a job from a mild steel/aluminum rod on a conventional Lathe machine
6. Job making on a drilling machine.
7. Gear cutting using milling machines.
8. Fabrication of a specimen of a given dimension using compression molding.
9. Fabrication of a specimen of a given dimension using Injection molding.

Textbooks:

1. Amitabha Ghosh and Mallick A.K., Manufacturing Science. Affiliated *East-West Press Pvt. Ltd.* 2010.
2. Kalpakjian S, Schmid S R, *Manufacturing Engineering and Technology* (2013), 6th Edition, Publisher: Prentice Hall.
3. Gibson D. W. Rosen, Brent Stucker, Additive Manufacturing Technologies: *Rapid Prototyping to Direct Digital Manufacturing*, Springer Publications.

Reference Books:

1. Callister, William D., and David G. Rethwisch. Fundamentals of materials science and engineering. John Wiley & Sons, 2022.
2. P. N. Rao, Manufacturing Technology Volume-II, McGraw Hill Education, New Delhi, 2013.
3. J. S. Campbell, Principles of Manufacturing Materials and Processes, Tata McGraw Hill, 1995.
4. P. C. Pandey and H. S. Shan, Modern Machining Processes, McGraw Hill Education, 2017.
5. E. P. DeGarmo, J. T. Black, R. A. Kohser, Materials and Processes in Manufacturing, 9th Edition, 2003, Wiley.
6. W. A. Knight and G. Boothroyd, Fundamentals of Metal Machining and Machine Tools, 3rd Edition, 2005, CRC Press.

Online Resources:

1. Fundamentals of Manufacturing Processes, Prof. D. K. Divewdi IIT Roorkee (https://archive.nptel.ac.in/courses/112/107/112107219/)
2. Manufacturing processes by A.B Chattopadhyay (IIT Kharagpur), NPTEL Course (https://archive.nptel.ac.in/courses/112/105/112105126/)

MEC209C Complex Variables and Laplace Transform 3-0-0-0

Course Objectives: This course equips students with advanced mathematical tools for engineering applications. Students will master integral calculus techniques, including definite and indefinite integration, and apply them to solve engineering problems. They will develop a thorough understanding of Fourier analysis—covering Fourier series and transforms—and use these methods to address real-world challenges. Additionally, the course covers Laplace transforms, including their properties and inverse transforms, enabling students to analyze and solve dynamic system problems in engineering contexts.

Course Outcomes: At the end of this course, a student will be able to:

1. Develop a strong foundation in integral calculus, including the ability to perform various types of integrations and apply them to solve engineering problems.
2. Gain a comprehensive understanding of the theory and principles of Fourier analysis.
3. Achieve proficiency in Laplace transforms, understanding their properties and applications.
4. Apply integral calculus, Fourier analysis, and Laplace transforms to analyze and solve engineering problems.
5. Develop the ability to recognize opportunities to apply integral calculus, Fourier analysis, and Laplace transforms in interdisciplinary engineering contexts.

Module I

Laplace transform: shifting theorem, Laplace transforms of derivatives and integrals, Heaviside's unit function. Dirac Delta function and its Laplace transforms. Laplace transforms of periodic functions, Heaviside's expansion theorem.

Module II

Inverse Laplace transforms: initial and final value theorems. Convolution theorem and its applications, use of Laplace transforms in the solution of linear differential equations.

Module III

Complex analysis: Complex variables, analytic functions, Cauchy Riemann equations. Complex integration, Cauchy's fundamental theorem, Cauchy's integral formula, Cauchy's inequality and Liouville's theorem on integral function.

Module IV

Expansions and Series in calculus: Taylor's & Laurent's expansions, Zeros & poles of analytic functions, Residues. Fourier series, Harmonic analysis.

Module V

Fourier transform: Fourier sine and cosine transform. Fourier integral formula and its applications to the solution of boundary value problems.

Text Books:

1. E. B Saff., and A. D Snider., Fundamentals of Complex Analysis for Mathematics, Science, and Engineering, Prentice Hall India, New Delhi.
2. R. V. Churchill, Complex variables and applications, McGraw Hill Education (India).
3. N. Snedden, The use of Integral Transforms, McGraw Hill Education (India).

Reference Books: NA

Online Resources:

1. Engineering Mathematics II by Prof. Jitendra Kumar (IIT Kharagpur) NPTEL Course (https://nptel.ac.in/courses/111105134).

MEC215C Introduction to Robotics and Automation 2-0-0-0

Course Objectives: This course will equip students with the ability to describe the historical evolution and significance of robotics and automation, classify various types of robots and automation systems, and identify key components of robotic systems. Students will analyze the applications of robotics across industries, and evaluate recent advancements and future trends in robotics.

Course Outcomes: At the end of this course, a student will be able to:

1. Describe the evolution, definitions, and significance of robotics and automation in modern industries.
2. Classify various types of robots and automation systems based on structure, mobility, and application.
3. Identify key components of robotic systems and demonstrate basic interfacing and programming.
4. Analyze real-world applications, advancements, and societal impacts of robotics and automation.

Module I: Fundamentals, Evolution, and Terminologies

Definitions and distinctions between robotics and automation; key robot terminologies (degree of freedom, workspace, precision, repeatability, etc.); historical milestones and pioneers in robotics; evolution from early automation to intelligent robotics; significant breakthroughs and landmark projects; relevance in the context of Industry 4.0.

Activity: Create a timeline of major events in robotics and automation history.

Module II: Classification, Specifications, and Standards

Classification of robots based on structure, mobility, functionality, and application; types of automation systems: fixed, programmable, and flexible; overview of robotic arms, AGVs, drones, aerial robots, mobile robots, and collaborative robots (cobots); robot generations and their evolution; robot specifications: payload, speed, reach, accuracy, resolution, and repeatability; introduction to relevant ISO and ANSI standards in robotics (e.g., ISO 8373, ISO 10218, safety standards).

Activity: Lab-based comparative analysis of different robot types and their specifications.

Module III: Components and Technologies in Robotic Systems

Hardware components: mechanical structure, joints, links, end-effectors, sensors, actuators, and controllers; Software components: basic control systems, programming languages, and control algorithms; communication protocols, data interfaces, and networking; integration of subsystems in robotic platforms.

Activity: Hands-on identification of robotic parts and components, and basic programming using Arduino or similar platforms.

Module IV: Applications, Advancements, and Societal Impact

Applications of robotics and automation in manufacturing, assembly, packaging, agriculture, logistics, healthcare, and service sectors; benefits in terms of productivity, quality, safety, and

innovation; recent advancements: AI, machine learning, soft robotics, bio-inspired robots, HRI (Human-Robot Interaction); future opportunities in space and underwater robotics; discussion on economic, ethical, regulatory, and workforce implications.
Activities: Group discussion on the impact and challenges of automation. Debate on ethical implications of advanced robotics. Industrial/field visit to observe robotic systems in practice.

Text Books:

1. Saha, Subir Kumar. *Introduction to Robotics*, 3rd Edition. McGraw Hill Education India, 2024.

Reference Books:

1. Nof, Shimon Y., editor. *Springer Handbook of Automation*. Springer, 1st Edition, 2009.
2. Siciliano, Bruno, and Oussama Khatib, editors. *Springer Handbook of Robotics*. Springer, Berlin/Heidelberg, 1st ed., 2008.
3. Musa, Ahmed. *The History of Automation: From Steam Engines to Robots*. 2024
4. Ichbiah, Daniel. *Robots: From Science Fiction to Technological Revolution*. Harry N. Abrams, 2005.
5. Kurzweil, Ray. *The Age of Intelligent Machines*. MIT Press, 1990.

Online Resources:

1. Introduction to Robotics: MIT OCW: https://ocw.mit.edu/courses/2-12-introduction-to-robotics-fall-2005/

MEC217C Thermal Engineering Principles 2-0-0-0

Course Objectives: To provide students with a foundational understanding of thermodynamic systems and energy interactions, focusing on the laws of thermodynamics, entropy, and thermodynamic cycles. The course emphasizes the application of these concepts to energy analysis, thermal efficiency, and thermal management in robotic systems, including actuators, embedded systems, and mobile autonomous platforms.

Course Outcomes: At the end of the course, a student will be able:

1. To describe thermodynamic systems, properties, and temperature measurement.
2. To apply the First Law and SFEE to analyze energy transfer in robotic systems.
3. To analyze the Second Law, entropy, and irreversibility in real processes.
4. To evaluate thermodynamic cycles relevant to automation and energy systems.
5. To apply thermodynamics to design and assess energy systems in robotics.

Module I

Thermodynamic Systems and Energy Interactions: Macroscopic view of thermodynamics; system, surroundings, and boundaries, Thermodynamic properties, processes, and cycles, Zeroth Law and temperature measurement, Work and heat transfer concepts, First Law of Thermodynamics, Enthalpy and Steady Flow Energy Equation (SFEE), Applications in robotic actuators, battery energy tracking, and embedded thermal modeling.

Module II

Second Law of Thermodynamics and Entropy: Limitations of First Law, directionality of processes, Heat engines, refrigerators, and thermodynamic efficiency, Kelvin-Planck and Clausius statements, Carnot cycle and thermodynamic temperature scale, Entropy: definition, change during processes, Clausius inequality, Irreversibility and available energy concepts, Relevance to system efficiency, thermal constraints in mobile and autonomous robots.

Module III

Thermodynamic Cycles and Energy Systems for Robotics: Air-standard cycles: Otto, Diesel, Dual, Brayton , Reversed Carnot cycle , Vapour compression refrigeration cycle and COP, Basics of compressors and turbines: working principles and relevance, Applications in robotic platforms: Thermal management systems, Energy generation and conversion for UAVs, AGVs, and autonomous systems

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Text Books:

1. Y. A. Cengel, Thermodynamics: An Engineering Approach, McGraw Hill Education, 8th edition, 2017.
2. T. D. Eastop, Applied Thermodynamics for Engineering Technologist, Pearson Education, 5th edition, 1993.

Reference Books:

1. Michael J. Moran and Howard N. Shapiro, Fundamentals of Engineering Thermodynamics,

John Wiley & Sons, 8th edition, 2014.
2. R. E. Sonntag, C. Borgnakke C. and G.J. Van Wylen, Fundamentals of Thermodynamics, John Wiley & Sons.
3. P. K. Nag, Engineering Thermodynamics, McGraw Hill Education.

Online Resources:

1. Engineering Thermodynamics by Prof. D.P. Mishra (IIT Kanpur), NPTEL Course **https://onlinecourses.nptel.ac.in/noc20_ae09/preview**
2. Applied Thermodynamics by Dr. Babu Visvanathan (IIT Madras), NPTEL Course (**https://archive.nptel.ac.in/courses/112/106/112106314/**)

MEC204C Machine Drawing and Solid Modelling 1-0-4-0

Course Objectives: This course is designed to equip students with essential skills in interpreting and creating technical drawings of machine components, including orthographic, isometric, and sectional views. Students will learn to analyze and assemble different machine parts while understanding standard tolerances, symbols, and annotations. Additionally, the course introduces Solid Modeling using CAD software, enabling learners to design and visualize mechanical components in a digital environment. By the end, students will gain hands-on experience in both drafting and 3D modeling, preparing them for practical applications in mechanical engineering and design.

Course Outcomes: At the end of this course, a student will be able to:

1. Comprehend basic production and assembly drawings.
2. Create assembly drawing of machine components from part drawing.
3. Use drawing display tools, sketching tools, geometric relations and dimension the sketch in CAD software.
4. Create base features like extrude, revolve etc. for a solid model.
5. Use advanced modelling tools in creating solid models.

Module I

Introduction to Machine Drawing: Production drawing, assembly drawing. Review of drawing in first angle and third angle projection. Orthographic projections of machine blocks, sectional views. Code of practice for Engineering Drawing, BIS specifications – Welding symbols, riveted joints, keys, fasteners. Reference to handbook for the selection of standard components like bolts, nuts, screws, keys etc.

Module II

Assembly Drawing: Half and Full sectional views, Fasteners & Fixtures: Nut and bolt assembly, Riveted joints, Knuckle joint, Oldham's coupling, Footstep bearing, Plummer block, Screw Jack, Tailstock.

Module III

Introduction to Solid Modelling Sketching: Basic sketching, sketching planes, sketching tools; lines arcs, circle, rectangle, polygon etc, sketching environment, various terms used in the sketching environment, sketching planes, drawing display tools, geometric relations, dimension the sketch, editing/modifying sketching, concept of fully defined sketches, patterns.

Module IV

Base Features: Solid base extrude, thin base extrude, solid base revolve, displaying the model, applying material to the model, changing the appearance of models.

Module V

Advance Modelling Tools: create holes, fillet, chamfer, sweep, loft, introduction to assembly module, introduction to drawing module. Various sub-components/parts of machine elements, to be

developed on SolidWorks, Autodesk Inventor.

Text Books:

1. SOLIDWORKS: A Power Guide for Beginners and Intermediate Users by CADArtifex
2. K. L. Narayana, P. Kannaiah and K. Venkata Reddy, Machine Drawing, New Age International

Reference Books:

1. A. Reyes, Beginner's Guide to SOLIDWORKS: Level 1 by MSME, CSWE.
2. D. T. Banach, Autodesk Inventor 2024 Essentials Plus, SDC Publications
3. N. D. Junnarkar, Machine Drawing, Pearson Education India.

Online Resources:

1. Computer Aided Engineering Design by Dr. Anupam Saxena (IIT Kanpur), NPTEL Course (https://nptel.ac.in/courses/112104031).
2. Engineering Drawing and Computer Graphics by Prof. Rajaram Lakkaraju (IIT Kharagpur), NPTEL Course (https://archive.nptel.ac.in/courses/112/105/112105294/**).**

CSE207C Applied Python for Robotics 0-0-4-0

Course Objectives: The objective of this course is to provide students with a comprehensive understanding of Python programming and its application in robotics. Through hands-on practicals, students will learn to interface Python with robotic hardware, utilize key libraries, and implement fundamental robotics principles.

Course Outcomes: At the end of this course, a student will be able to:

1. Understand the basics of Python programming.
2. Learn the use of Python libraries for robotics, such as NumPy, OpenCV, matplotlib, pySerial, and Robot Operating System (ROS).
3. Apply Python skills to solve simple robotics problems
4. Gain experience in working with sensors, actuators, and basic robotic algorithms
5. Develop skills in robotic simulations, autonomous navigation, and hardware interfacing.

List of Practicals

1. Write a Python program to demonstrate basic syntax, variables, and data types (int, float, complex).
2. Create a Python script to perform operations on lists, tuples, dictionaries, and sets.
3. Develop a Python program that uses control structures (e.g., if-else statements, loops) to perform basic robotic decision-making.
4. Write functions to perform basic robotic calculations (e.g., converting sensor data from one unit to another). Demonstrate importing and using these functions in a main program.
5. Create a simple Python module for robot navigation that includes functions for distance and angle calculations, and import it into a different Python script.
6. Design a class in Python representing a robot with attributes (e.g., name, battery level) and methods (e.g., move, charge). Instantiate objects and simulate their behavior.
7. Extend the robot class to include specific sensor and actuator attributes, simulating a basic robot framework.
8. Write a Python script using **NumPy** to handle large datasets, such as sensor arrays, and calculate statistical measures (e.g., average, variance).
9. **Matplotlib**: Create a program to visualize robot path data or sensor readings (e.g., plotting distance over time).
10. Use **OpenCV** with Python to capture and display live video feed from a camera for basic object detection.
11. **pySerial**: Write a program to establish serial communication between Python and an Arduino board, sending commands from Python to the Arduino.
12. Set up a basic Robot Operating System **(ROS)** environment and write a Python script to publish sensor data to a ROS topic.
13. Write a Python program to read temperature data from a sensor using **pySerial** and display the data in real-time.
14. Implement code to control a robotic arm by simulating basic movement patterns (e.g., grasp, rotate), pick-and-place tasks etc.
15. Connect and program an ultrasonic sensor to measure distance using Python and visualize

the data.

16. Write a Python script to turn an LED on and off based on distance data from a sensor, simulating a simple proximity-based alert system.
17. Read data from a gyroscope sensor to track the orientation of a robot, and display the orientation data in real time.
18. Design a simple obstacle avoidance program that uses Python to interpret distance data and adjust motor direction.
19. Program a robot to avoid obstacles using Sensor/LIDAR/Ultrasonic data and Python.
20. Create a simple vision system that detects and tracks colored objects in real-time using OpenCV.

Textbooks:

1. Python All-in-One for Dummies, *John C. Shovic & Alan Simpson,* 3rd Edition, 2024, John Wiley & Sons
2. Learning Robotics Using Python, *Lentin Joseph,* 2nd Edition, 2018, Packt Publishing

Reference Books:

1. Python for Everyone – *Saurabh Chandrakar & Dr. Nilesh B. Bahadure,* 1st Edition, 2023, BPB Publications.
2. Python Robotics Projects – *Prof. Dr. Giacomo Calafiore*
3. Programming Robots with ROS – *Morgan Quigley, Brian Gerkey & William D. Smart,* 2015, O'Reilly Media

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Online Resources:

1. Python Official Documentation: https://docs.python.org/3/
2. OpenCV Documentation: https://docs.opencv.org/
3. Robotics with Python Blog: https://realpython.com/python-robotics/
4. ROS (Robot Operating System) Tutorials: http://wiki.ros.org/ROS/Tutorials

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