Class 10

Answer Key

Part 1: Robotics

Robotics & Artificial Intelligence (Ver 1.0)

1. New Age Robotic Systems

Task (Page 34)

Nanobots, at 1 to 100 nanometers, are tiny machines with immense potential in healthcare. They excel in targeted drug delivery, minimizing side effects and enhancing treatment efficacy. Equipped with sensors, nanobots aid early disease detection, improving treatment outcomes. They can perform minimally invasive surgeries at the cellular level, offering precision and less invasiveness. Nanobots also enable continuous monitoring of vital signs, providing real-time data to healthcare professionals. However, ethical considerations, biocompatibility, and privacy concerns must be addressed. Overall, nanobots have the potential to revolutionize healthcare by offering precise diagnostics, targeted treatments, and minimally invasive interventions.

Task (Page 36)

Accept all relevant answers.

Reboot (Page 37)

1. A smart ecosystem refers to an interconnected network of various devices, systems, and entities that work together to create an intelligent and efficient environment. It involves the integration of technology, data, and connectivity to improve the quality of life, enhance sustainability, and optimise resource utilisation.
2. The essential components of a smart ecosystem are:
   - Smart Infrastructure
   - Internet of Things (IoT) Devices
   - Data Analytics and Artificial Intelligence (AI)
   - Integration and Interoperability
   - Sustainability and Resource Optimization
   - Enhanced Quality of Life
   - Collaboration and Stakeholder Engagement

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Exercise

Unsolved Questions

SECTION A (Objective Type Questions)

Quiz

A. . 1. Deep learning

2. Exoskeleton robots
3. To provide support and facilitate movement during therapy sessions.
4. All of the above
5. Elephants are animals

B. 1. Driver-assisted cars 2. Weed control robots

3. Rehabilitation Robots 4. Data analytics and AI technologies

5. Autonomous Drones

C. 1. False 2. True 3. TRUE 4. False 5. True

SECTION B (Subjective Type Questions)

A. 1. New Age Robotic Systems can create engaging and interactive learning environments. They can act as educational aids, answer students' questions, demonstrate concepts through practical examples, and promote critical thinking and problem-solving skills.

2. The components to illustrate the functioning of NARS are:

i. Term Logic

ii. Attention Allocation

iii. Inference and Judgment

iv. Learning and Anticipation

3. While New Age Robotic Systems have the potential to assist and enhance the learning experience, it's unlikely that they can completely replace human teachers. Human teachers bring unique qualities such as empathy, emotional intelligence, adaptability, and the ability to understand and respond to individual student needs. Robotic systems can play a supportive role by providing additional resources, personalized learning experiences, and automation of certain tasks, but the social and emotional aspects of education are crucial and are best addressed by human educators.

4. Students interested in working with New Age Robotic Systems can pursue various paths:

a. **Educational Programs:** Enroll in academic programs or courses related to robotics, artificial intelligence, or computer science.

b. **Extracurricular Activities:** Join robotics clubs, coding competitions, or other extracurricular activities that involve working with technology.

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c. **Internships and Research Opportunities:** Seek internships or research positions with organizations and institutions that focus on robotics and AI.

d. **Self-learning:** Utilize online resources, tutorials, and platforms to learn programming languages, robotics, and AI concepts independently.

5. Engaging with New Age Robotic Systems can help students develop a variety of valuable skills:

a. **Programming Skills:** Learning how to code and program robots or AI systems is a fundamental skill in this field.

b. **Problem Solving:** Working with robotics often involves overcoming technical challenges and solving problems creatively.

c. **Critical Thinking:** Understanding how robotic systems operate and making decisions based on their outputs fosters critical thinking skills.

d. **Collaboration:** Many robotics projects require collaboration, teaching students how to work effectively in a team.

e. **Adaptability:** The field of robotics is dynamic, and students will learn to adapt to new technologies and advancements.

f. **Creativity:** Designing and implementing robotic solutions often involve creative thinking and innovation.

g. **Ethical Considerations:** Working with AI and robotics raises ethical questions, and students can develop an understanding of the ethical implications of technology.

6. Autonomous drones have applications in various sectors, including film and media for aerial photography, agriculture for crop monitoring, and delivery services for last-mile transportation, ground forces for battle support.

7. Telepresence robots enable remote patient monitoring, consultation, and healthcare delivery. These robots consist of a mobile base with a screen, camera, and microphone. Healthcare professionals can remotely operate these robots to interact with patients, conduct check-ups, and provide consultations.

8. A smart ecosystem typically consists of multiple components, including smart infrastructure, Internet of Things (IoT) devices, data analytics, and intelligent systems.

9. The key features of smart homes that make them increasingly popular and desirable are:

i. Connectivity and Control

ii. Home Automation

iii. Energy Efficiency

iv. Enhanced Security

v. Convenience and Comfort

vi. Home Monitoring and Safety

vii. Integration and Compatibility

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10. Agricultural robots or Agribots are designed to automate tasks such as planting, harvesting, monitoring crop health, and precision spraying.

B. 1. Crop monitoring robots equipped with various sensors, including cameras, spectrometers, and multispectral imaging systems, assess crop health, detect diseases, and monitor growth patterns. They capture high-resolution data, enabling farmers to make informed decisions regarding irrigation, fertilization, and pest control. Spraying robots utilize this data to perform targeted and precise spraying of fertilizers, pesticides, or herbicides, minimizing chemical usage and improving cost-effectiveness.

2. Pharmacy robots can be used to accurately sort, package, and label medications. It also reduces the chances of errors and improves efficiency. They can handle high volumes of prescriptions, track inventory, and ensure the right medication is delivered to the right patient at the right time.

3. Robotics has brought significant advancements to the field of medicine and healthcare, offering a wide array of benefits:
   - **Improved Surgical Outcomes:** The precision and enhanced visualization provided by surgical robotics systems result in improved surgical outcomes, such as reduced complications, shorter hospital stays, and faster recovery times for patients.
   - **Increased Surgical Capabilities:** Robotic systems expand the surgical capabilities of healthcare professionals. Surgeons can perform complex procedures with greater ease and precision, reaching anatomical areas that may be challenging to access with traditional surgical approaches.
   - **Reduced Trauma and Pain:** Minimally invasive robotic procedures result in smaller incisions, reduced tissue damage, and less postoperative pain compared to open surgeries. Patients experience faster healing and can return to their normal activities more quickly.
   - **Remote Access to Expertise:** Robotic systems enable teleoperation and remote surgery, allowing surgeons to provide specialized care to patients in remote or underserved areas. Patients can benefit from expert medical opinions and procedures without the need to travel long distances.
   - **Training and Education:** Surgical robotics systems provide a valuable platform for training and education. Surgeons can practice complex procedures in a controlled environment, enhancing their skills and ensuring standardized training across different healthcare institutions.

4. Drones can play a crucial role in environmental monitoring and conservation efforts. They can autonomously survey and collect data on wildlife populations, monitor deforestation, assess the health of ecosystems, and track changes in land use patterns. Autonomous drones provide a cost-effective and efficient means of gathering environmental data over large areas.

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5. The key components of NARS to illustrate its functioning are:

- **Term Logic:** NARS employs a language-like formalism called term logic to represent knowledge. In term logic, statements are expressed using terms, which are composed of concepts and relations.
- **Attention Allocation:** NARS allocates attention to different statements or tasks based on their relevance and importance. The attention allocation process determines the level of processing resources dedicated to each task.
- **Inference and Judgment:** NARS performs both deductive and inductive reasoning to draw conclusions from the available knowledge. Deductive reasoning involves applying logical rules to derive new statements from existing ones. Inductive reasoning involves generalizing from specific instances to form more abstract knowledge. The system evaluates the plausibility of conclusions through a process called judgment, which assigns a degree of truth and reliability to each statement.
- **Learning and Anticipation:** NARS has a learning mechanism called "anticipation and update" that allows it to acquire new knowledge from experience. When faced with a novel situation, NARS generates anticipations or predictions about what might happen. If the actual outcome matches the anticipation, the system reinforces its beliefs. If the outcome contradicts the anticipation, the system updates its knowledge by revising or discarding certain statements.

C. Competency-based/Application-based questions:

1. c. The robot adjusts irrigation and shading based on real-time data, optimising plant care.

2. From Robots to Cobots

Reboot (Page 54)

1. Swarm robot is the most common type of microbots.
2. Because of their small size, microbots can be manufactured at a lower cost than larger robots. Hence they are cost-effective.

Reboot (Page 63)

1. Two types of aerial robots are fixed-wing drones and multirotor drones.
2. UUV stands for Unmanned Underwater Vehicles.
3. Two advantages of underwater robots are:
   - the ability to operate in environments that are inhospitable to humans.
   - the ability to reach depths that are difficult or impossible for divers to reach.
4. Two advantages of mobile robots are:
   - One major advantage of mobile robots is their computer vision capabilities.
   - The onboard intelligence system and AI used by AMRs creates another advantage.
5. Humanoid robots are robots that resemble and act like humans.
6. The environmental limitations of insectbots are Insectbots may not be able to operate in all types of environments, especially those with extreme temperatures, high humidity, or rough terrain.

Exercise

Unsolved Questions

SECTION A (Objective Type Questions)

Quiz

A. 1. a. 2. d. 3. c. 4. b. 5. d.

6. b. 7. c. 8. b.

9. (This question was printed incorrectly in the book. Please correct it in your textbook.)

Ques. What is the typical payload capacity of a cobot?

a. 3-35 kg b. 1-10 kg

c. 10-35kg d. More than 100 kg

Ans. a. 3-35 kg

10. d.
11. Both machine learning and computer vision.
12. Robots are designed to resemble humans.
13. Sensors
14. Computing System.
15. Perception Systems

B. 1. Whiz 2. control systems 3. Controllers
4. Machines 5. Actuators

C. . 1. True 2. False 3. True 4. True 5. True

Section B (Subjective Type Questions)

A. 1. Yes, Because a cobot, or collaborative robot, is a robot designed to work safely alongside humans in a shared workspace.

2. Actuators are responsible for converting electrical or pneumatic signals into physical motion. They enable the robot to move its limbs or other mechanical parts. Examples of actuators include motors, servos, hydraulic systems, and pneumatic systems.

3. The advantages of using Cobots in industries are:
   - i. **Safety:** Cobots are safe to work alongside humans with slow speeds and soft-stop technology.
   - ii. **Flexibility and Adaptability:** Cobots are lightweight, portable, and easily reconfigurable for diverse tasks and environments.
   - iii. **Ease of Programming:** Cobots have user-friendly interfaces and teach-by-demonstration methods simplify programming.
   - iv. **Enhanced Ergonomics:** Cobots have been designed with human ergonomics in mind, reducing strain on workers.
   - v. **Cost-effectiveness:** Cobots are typically less expensive than traditional robots, making them accessible for small businesses.
   - vi. **Collaboration:** Cobots are specifically designed for easy collaboration with humans, allowing direct interaction in tasks.

4. Robots require a power source to operate. This can be a battery, fuel cell, or direct electrical connection.

5. . The first cobot was invented in 1996 by J. Edward Colgate and Michael Peshkin.

B. 1. Robots have the ability to dynamically interact with their surroundings. While machines typically follow predefined responses to specific inputs, robots are equipped with sensors like cameras, depth sensors, force sensors, and tactile sensors. These sensors enable robots to detect and respond to various elements such as objects, people, or events within their environment. This enhanced perceptual capability allows robots to perform tasks like navigation, object manipulation, obstacle avoidance, and more sophisticated interactions with humans.

2. The difference between cobots and traditional robots are as follows:

Application	Cobots	Traditional Robots
Education and learning about robotics	**Good Fit:** They reduce risk of injury, typically don't need guarding, and tend to have a shallow learning curve.	**Mediocre Fit:** More time consuming to learn, will require appropriate safety rated sensors and/or guarding higher risk of injury.
High speed work (e.g., case packing or pick and place)	**Poor Fit:** Lower speed will reduce cycle time and limit the benefits of automation for high-volume products.	**Good Fit:** These systems are designed to run at high continuous speeds.
Very high accuracy work (e.g., assembling micro circuit boards)	**Mediocre Fit:** Accuracy varies with cobot models, but in general it is harder to get very high accuracy in a cobot.	**Good Fit:** Traditional robots are about speed, payload and accuracy so finding one that meets the requirements in frequently much simpler.
High payload work (moving heavy parts)	**Not possible with cobots:** Cobots typically have a payload capacity between 3 and 35 kilograms.	**Good Fit:** Traditional robots have payload capacities up to the weight of a car, so payload is usually not a problem.
Force sensitive work	**Good Fit:** Some cobots have built in force control which can be integrated into the control loop without extra sensors.	**Mediocre Fit:** Traditional robots can have force control devices added between the tool flange and the end effector, but this is a separate unit and only gives force control at the tool.
Processes in which the robot is working close to a human	**Good Fit:** Safety and risk assessments must still be considered, but this is a distinguishing cobot feature.	**Poor Fit:** Not possible without safety systems (e.g., guarding and safety rated switches and sensors) in place.

Explosive environment (e.g., painting)	**Not possible for cobots:** Currently no explosive environment rated cobots.	**Good Fit:** Paint robots are readily available for this application.

3. There are various integrated components of Robots:
   - **Power Supply:** Robots require a power source to operate. This can be a battery, fuel cell, or direct electrical connection.
   - **Actuators:** Actuators are responsible for converting electrical or pneumatic signals into physical motion. They enable the robot to move its limbs or other mechanical parts. Examples of actuators include motors, servos, hydraulic systems, and pneumatic systems.
   - **Sensors:** Sensors allow the robot to perceive and interact with its environment. They provide feedback on various physical properties such as position, orientation, proximity, temperature, pressure, and more. Common types of sensors include cameras, ultrasonic sensors, infrared sensors, tactile sensors, and gyroscopes.
   - **Controller / Control System:** The control system consists of hardware and software components that govern the robot's behavior and operations. It processes sensory information, makes decisions, and generates commands for the actuators. The control system can range from simple microcontrollers to complex artificial intelligence algorithms.
   - **Manipulators:** Manipulators are robotic arms or appendages designed to perform specific tasks. They are equipped with joints, linkages, and end-effectors to interact with objects or the environment.
   - **Communication Interface:** Robots often require a communication interface to interact with humans or other systems. This can include displays, buttons, touchscreens, speakers, microphones, and wireless communication modules.
4. The role of Companion Cobots is crucial due to the research findings that highlight the negative impacts of chronic loneliness on older adults, including effects on memory, physical well-being, mental health, and life expectancy. With a growing elderly population, the rise of nuclear families worldwide, longer life expectancies, and the increasing burden of chronic illnesses, Companion Cobots have the potential to provide companionship and alleviate the adverse effects of loneliness on seniors' overall well-being.

C. Competency-based/Application-based questions:

To adapt to the planet's environment, the robot's design should consider factors like extreme temperatures, low gravity, and surface conditions. It might need specialized wheels or legs for traction, protective shielding against radiation, and efficient power systems. Sensors for temperature, chemical analysis, and cameras for navigation would be crucial, along with tools for collecting and storing soil samples in the alien terrain.

Deep Thinking (Page 70)

Do yourself.

Lab Activity (Page 71)

Do yourself.

3. Components of Robots as A System

Reboot (Page 77)

1. Locomotion can be achieved using various types of mechanisms, including wheels, legs, tracks, or aerial propellers, depending on the application and environment.
2. No, this statement is not correct. The correct statement is given below:

   In helical motion, the robot moves along a linear path while simultaneously rotating around its axis.

Exercise

Unsolved Questions

SECTION A (Objective Type Questions)

Quiz

A. 1. a 2. c 3. c 4. d 5. c

6. d 7. a

B. 1. Sun Gear 2. GPS and LiDAR

3. Range and Proximity Detection

4. Actuators 5. rack, pinion. 6. Pneumatic rotary

C. 1. True 2. False 3. True 4. True 5. True

Section B (Subjective Type Questions)

A. 1. GPS is a widely used navigation sensor that utilizes a network of satellites to determine the position, velocity, and time synchronization of a receiver. GPS receivers calculate their position by receiving signals from multiple satellites and analyzing the time delays and positions of those satellites.

2. Infrared (IR) sensors use infrared light to detect the presence and proximity of objects. These sensors emit infrared light and measure the reflection or intensity of the light when it interacts with objects.

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3. The various applications of actuators in the field of robotics are Robot Manipulation, Robot Mobility, Industrial Automation, Medical Robotics, Aerospace and Space Exploration, Autonomous Vehicles, Entertainment and Humanoid Robots, and Research and Education.
4. Linear actuators convert electrical, hydraulic, or pneumatic energy into linear motion. Linear actuators are commonly used in applications that require linear movement or positioning.
5. The hydraulic rotary joint allows the flow of hydraulic fluid to the actuator while maintaining a continuous connection.

B. 1. The fundamental functions of gears in mechanical systems are as follows:

i. **Transmission:** Gears primarily transmit mechanical power from one component to another. They transfer rotational motion and torque from a driving shaft to a driven shaft, allowing the efficient transfer of energy within a system.

ii. **Speed Adjustment:** Gears adjust rotational speed between input and output shafts. By employing gears with different numbers of teeth, the speed can be increased or decreased, allowing the system to operate at desired speeds.

iii. **Torque Conversion:** Gears are instrumental in converting torque. Torque refers to the rotational force applied to an object. Gears with varying sizes can be combined to increase or decrease the torque output. This feature is crucial for adapting the system to different loads or requirements.

iv. **Directional Control:** Gears facilitate the change in the direction of rotational motion. By meshing gears at different angles, such as with bevel gears, the rotational force can be redirected by 90 degrees or to any desired angle. This allows for versatile movement and control in mechanical systems.

v. **Gear Reduction and Amplification:** Gears can reduce or amplify rotational speed and torque. This feature allows for adapting the system to specific requirements, such as achieving high torque for heavy lifting or high-speed rotation for fast movements.

vi. **Mechanical Advantage:** Gears provide a mechanical advantage by multiplying or magnifying the applied force. The output force can be increased or decreased by employing gears with different diameters relative to the input force. This feature is especially useful in applications requiring additional force to overcome resistance or perform heavy-duty tasks.

2. Contact-type sensors physically come into direct contact with objects or the environment to gather information. They measure parameters by sensing the physical interaction between the sensor and the object. The various examples of contact-type external sensors include tactile sensors, force/torque sensors, and contact probes. Whereas, Non-contact-type sensors do not require physical contact with objects or the environment. They gather information without direct interaction by utilizing different physical principles such as light, sound, or electromagnetic fields.

   The various examples of non-contact-type external sensors include cameras, range finders, infrared sensors, and proximity sensors.

3. To link actuators to robotic wheels, several methods can be used based on the type of actuators. Here are some examples:
   i. **DC Motor-Driven Wheels:** DC motors are frequently used to power wheels in robotics, particularly in mobile robots. By controlling the speed and direction of the motors on each wheel, the robot can achieve movement and navigate its environment. Differential drive and omnidirectional drive configurations are commonly implemented using DC motor-driven wheels.
   ii. **Stepper Motor-Driven Wheels:** Stepper motors can also be utilized to drive wheels in robots. Stepper motors allow for precise position control and are commonly used in applications that require accurate and repeatable movement, such as robotic platforms used in laboratory settings or precision manufacturing.
   iii. **Servo Motor-Driven Wheels:** Servo motors can be employed to drive wheels in robotic systems that require precise control over wheel motion. Servo motors offer accurate position feedback and are commonly used in robotic vehicles, drones, or robotic arms where precise movement is crucial.

D. Competency-based/Application-based questions:

a. Deploying robots equipped with cameras and sensors to monitor traffic conditions and adjust signal timings.

Deep Thinking (Page 90)

Do yourself.

Lab Activity (Page 90)

Do yourself.

4. Visualization, Design and Creation of Components

Reboot (Page 77)

1. Locomotion can be achieved using various types of mechanisms, including wheels, legs, tracks, or aerial propellers, depending on the application and environment.
2. No, this statement is not correct. The correct statement is given below:

   In helical motion, the robot moves along a linear path while simultaneously rotating around its axis.

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Exercise

Unsolved Questions

SECTION A (Objective Type Questions)

Quiz

A.	1. c	2. c	3. c	4. c	5. c
B.	1. CAD.	2. Revolute and Prismatic joints		3. Visualizing	
	4. performance and functionality.			5. projects	
C.	1. True	2. False	3. True	4. True	5. False

Section B (Subjective Type Questions)

A.
1. The four formats that Tinkercad supports are STL, OBJ, GLTF, and SVG.
2. Computer-Aided Design (CAD) software helps design and create detailed 3D models of robot parts before they are manufactured or assembled.
3. Former Google engineer Kai Backman and Mikko Mononen founded Tinkercad with the intention of making 3D modeling, especially for physical item design, accessible to the general public.
4. The key applications of mechanical blocks in robotics are:
   i. Robotic Arm Construction
   ii. Mobile Robot Chassis
   iii. Grippers and End Effectors
   iv. Sensor Mounting and Integration
   v. Educational Robotics
5. The combination of these joint types allows for a wide range of motion and flexibility in robotic and mechanical systems, making them highly adaptable for different applications.

B.
1. Tinkercad has a strong focus on education and is extensively used in schools and educational institutions. It offers a range of educational resources, tutorials, and projects that help students learn and practice design skills. This supports teaching about design, engineering, and 3D modeling in an interactive and engaging manner, making it a valuable tool for educators and learners alike.
2. The Revolute and Prismatic joints are essential for creating complex and versatile robotic systems and mechanical devices. Many robotic manipulators combine both types of joints to achieve various movements, such as picking up objects, painting, or assembling components on an assembly line. The combination of these joint types allows for a wide range of motion and flexibility in robotic and mechanical systems, making them highly adaptable for different applications.

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D. Competency-based/Application-based questions:

c. Robot marathons and building robots with enhanced speed and endurance capabilities.

Deep Thinking (Page 90)

Do yourself.

Lab Activity (Page 90)

Do yourself.