Robotics and AI

Course Code: BECCS3C015
Course Title: Robotics and AI
Semester: VI
Credits: 3

Rationale

The course "Robotics and AI" is designed to provide an interdisciplinary understanding of robotics and artificial intelligence. The integration of these fields is transforming industries by enabling the development of intelligent and autonomous systems. This syllabus ensures students gain foundational knowledge to excel in the rapidly evolving domains of robotics and AI.

Course Outlines

Contents	No. of Lectures
Unit I **Fundamentals of Robotics:** Definition, Components of a Robot, Types of Robots, Objectives of Robotics, Laws of Robotics, Benefits and Challenges of Robotics, Applications of Robotics, Robotic System Components (Sensors, Actuators, Control System). **AI for Robotics:** Overview of AI concepts, Goals of AI, Intelligent agents, Role of AI in robotics, perception, planning, learning, and decision-making in robotics.	8
Unit II Building Blocks of the Robots - Power Supply, Actuators, Sensors, Control Systems, End Effector, Communication System, User Interface, Structural Frame or Chassis, Locomotion or Mobility System, Software and Firmware of a Robot. Type of Motion (Linear Motion, Working of Pneumatic Actuators, Angular Motion, Circular Motion, Motion in One-Dimension, Motion in Two-Dimensions). Joints (Prismatic Joints, Prismatic Joints, Spherical Joints), Links (Rigid Links, Soft Links), Degree of Freedom of a Robot (Definition, Identification through Illustration, Quarky Robotic Arm, Quarky Humanoid Robot, Quarky Quadruped Robot, Practical Considerations)	8
Unit III **AI in Robotics:** Robotics with NLP (voice controlled robot, NLP for robot interaction, speech recognition and synthesis in robots), Computer Vision for Robotics (object recognition, edge detection, feature extraction, and segmentation), Reinforcement learning (RL) for robotics (introduction, agent, environment, state, action, reward, RL algorithms, exploration and exploitation dilemma in RL).	8
Unit IV	

Robot Operating System (ROS): Architecture, topics, services, and action clients. **Simulation Tools:** Using Gazebo/ UiPath for robotic simulations. **IoT Integration:** Communication between robots and IoT systems, MQTT protocol. **Real-World Applications:** Autonomous navigation, robotic arms, swarm robotics, principles of swarm intelligence, etc. Co-operative multi-robot system.	8
Unit V **Robotic Process Automation (RPA):** Introduction, Categories of RPA, Benefits of RPA, Challenges of RPA, RPA in Different Applications (BPO, BPM, BPA), On-Premise vs the Cloud, RPA Components, RPA Tools, RPA Orchestration, Future of Automation, RPA for software development	8

Course Outcomes

Upon successful completion of this course, students will be able to:

- Learn the fundamental principles, components, and applications of robotics and AI.
- Understand the designing methodology of integrating actuators, sensors, and control mechanisms in robotic systems.
- Explore AI techniques such as NLP, computer vision, and reinforcement learning for robotic systems.
- Investigate tools like ROS and Gazebo for robot simulation and assess IoT integration in robotics.
- Eplore robotic process automation (RPA) tools and their applications in various domains.

List of Books/References

1. Siciliano, B., Sciavicco, L., Villani, L., & Oriolo, G. (2010). Robotics: Modelling, Planning, and Control. Springer.
2. Russell, S., & Norvig, P. (2021). Artificial Intelligence: A Modern Approach (4th ed.). Pearson.
3. Craig, J. J. (2017). Introduction to Robotics: Mechanics and Control (4th ed.). Pearson.
4. Thrun, S., Burgard, W., & Fox, D. (2005). Probabilistic Robotics. MIT Press.
5. Tom, T. (2020), The Robotic Process Automation Handbook: A Guide to Implementing RPA Systems Apress.
6. Joseph, L. (2018). Robot Operating System (ROS) for Absolute Beginners: Robotics Programming Made Easy. Germany: Apress.
7. Sutton, R. S., & Barto, A. G. (2018). Reinforcement Learning: An Introduction (2nd ed.). MIT Press.
8. Murphy, R. R. (2019). Introduction to AI Robotics (2nd ed.). MIT Press.
9. Robotics and Automation in Industry 4.0: Smart Industries and Intelligent Technologies. (2024). (n.p.): CRC Press.
10. Ivanov, S., & Webster, C. (2020). Robotics, AI, and the Future of Work. Emerald Publishing.