**Roles & Responsibility Matrix:**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **WBS#** | **WBS Deliverable** | **Activity #** | **Activity to complete the deliverable** | **Duration (days)** | **Responsible Team Member(s) & Role(s)** |
| 1 | Project Initiation Phase | 1 | Literature Review | 7 | Bilal (A)  Hamza (R)  Mohsin (I)  Usama (R) |
|  |  | 2 | Define project scope and objectives | 5 | Bilal (A/R)  Hamza (C)  Mohsin (C)  Usama (I) |
|  |  | 3 | Establish project team roles and responsibilities | 1 | Bilal (A/R)  Hamza (C)  Mohsin (I)  Usama (I) |
|  |  | 4 | Setup project management tools and communication channels | 1 | Bilal (C)  Hamza (A)  Mohsin (I)  Usama (R) |
| 2 | Requirement Analysis | 5 | Research existing autonomous vehicle technologies and solutions | 3 | Bilal (C)  Hamza (A/R)  Mohsin (I)  Usama (I) |
|  |  | 6 | Gather requirements from stakeholders | 5 | Bilal (A)  Hamza (R)  Mohsin (C)  Usama (C) |
|  |  | 7 | Brainstorming | 2 | Bilal (R)  Hamza (A)  Mohsin (C)  Usama (C) |
|  |  | 8 | Define Problem Scenarios | 1 | Bilal (R)  Hamza (A)  Mohsin (C)  Usama (I) |
|  |  | 9 | Interview Domain Expert | 2 Meetings per week | Bilal (A)  Hamza (R)  Mohsin (I)  Usama (I) |
|  |  | 10 | Define Functional Requirements | 4 | Bilal (R)  Hamza (A)  Mohsin (C)  Usama (I) |
|  |  | 11 | Specify Non-Functional Requirement | 1 | Bilal (A/R)  Hamza (C)  Mohsin (I)  Usama (I) |
|  |  | 12 | System Overview | 2 | Bilal (C)  Hamza (R)  Mohsin (I)  Usama (A) |
|  |  | 13 | Constraints | 1 | Bilal (A/R)  Hamza (C)  Mohsin (I)  Usama (I) |
| 3 | System Design | 14 | Develop Architecture Diagram | 1 | Bilal (C)  Hamza (A/R)  Mohsin (I)  Usama (C) |
|  |  | 15 | Create Use Case Diagram | 1 | Bilal (C)  Hamza (A/R)  Mohsin (R)  Usama (I) |
|  |  | 16 | Define Detail Use Cases | 3 | Bilal (A) Hamza (R) Mohsin (I)  Usama (C) |
|  |  | 17 | Design Activity Diagrams | 3 | Bilal (C) Hamza (I)  Mohsin (A/R)  Usama (I) |
|  |  | 18 | Construct System Sequence Diagram | 1 | Bilal (C)  Hamza (A)  Mohsin (R)  Usama (I) |
| 4 | Simulation Environment Setup | 19 | Install and configure CARLA simulator, ROS Noetic and environment | 8 | Bilal (A)  Hamza (C)  Mohsin (I)  Usama (R) |
|  |  | 20 | Develop scripts for setting up simulation scenarios | 7 | Bilal (A/R)  Hamza (C)  Mohsin (I)  Usama (I) |
|  |  | 21 | Verify integration between CARLA and ROS | 1 | Bilal (A)  Hamza (R)  Mohsin (I)  Usama (I) |
| 5 | Path Planning Algorithm Development | 22 | Defining algorithms for path planning considering dynamic obstacles | 3 | Bilal (A/R)  Hamza (C)  Mohsin (C)  Usama (I) |
|  |  | 23 | Path planning logic in Python using ROS | 20 | Bilal (A)  Hamza (R)  Mohsin (I)  Usama (C) |
|  |  | 24 | Route Calculation | 5 | Bilal (C)  Hamza (A)  Mohsin (I)  Usama (R) |
|  |  | 25 | Map Processing | 1 | Bilal (A)  Hamza (I)  Mohsin (C)  Usama (R) |
|  |  | 26 | Environment Analysis | 2 | Bilal (A)  Hamza (R)  Mohsin (I)  Usama (C) |
|  |  | 27 | Trajectory Generation | 4 | Bilal (C)  Hamza (I)  Mohsin (R)  Usama (A) |
|  |  | 28 | Calculating Waypoints | 2 | Bilal (A)  Hamza (C)  Mohsin (I)  Usama (R) |
|  |  | 29 | Test path planning algorithms in simulated environments | 3 | Bilal (A)  Hamza (R)  Mohsin (I)  Usama (C) |
| 6 | Path Following Implementation | 30 | Defining control algorithms for vehicle control | 2 | Bilal (A/R)  Hamza (R)  Mohsin (I)  Usama (C) |
|  |  | 31 | Integrate path following logic/algorithm | 7 | Bilal (R)  Hamza (A)  Mohsin (C)  Usama (I) |
|  |  | 32 | Trajectory Tracking | 2 | Bilal (A)  Hamza (R)  Mohsin (C)  Usama (I) |
|  |  | 33 | Velocity Control | 3 | Bilal (A)  Hamza (C)  Mohsin (I)  Usama (R) |
|  |  | 34 | Steering Control | 5 | Bilal (C)  Hamza (A)  Mohsin (I)  Usama (R) |
|  |  | 35 | Conduct testing and validation in simulated environments | 5 | Bilal (C)  Hamza (R)  Mohsin (I)  Usama (A) |
| 7 | Obstacle Detection | 36 | Defining Machine Learning algorithms for detecting obstacles | 3 | Bilal (C)  Hamza (I)  Mohsin (A/R)  Usama (I) |
|  |  | 37 | Sensor Data Processing | 5 | Bilal (C)  Hamza (I)  Mohsin (A/R)  Usama (I) |
|  |  | 38 | Obstacle Detection | 7 | Bilal (A)  Hamza (C)  Mohsin (R)  Usama (I) |
|  |  | 39 | Distance Estimation | 5 | Bilal (C)  Hamza (A)  Mohsin (R)  Usama (I) |
| 8 | Obstacle Avoidance | 40 | Defining avoidance Maneuver | 1 | Bilal (C)  Hamza (A)  Mohsin (R)  Usama (I) |
|  |  | 41 | Implement obstacle avoidance strategies | 25 | Bilal (C)  Hamza (R)  Mohsin (A)  Usama (I) |
|  |  | 42 | Path Adjustment | 10 | Bilal (C)  Hamza (A)  Mohsin (R)  Usama (I) |
|  |  | 43 | Maneuver Planning | 5 | Bilal (C)  Hamza (I)  Mohsin (A)  Usama (R) |
|  |  | 44 | Real Time Responding | 5 | Bilal (I)  Hamza (C)  Mohsin (A/R)  Usama (C) |
|  |  | 45 | Integrate obstacle detection and avoidance with overall system | 5 | Bilal (C)  Hamza (I)  Mohsin (R)  Usama (A/R) |
| 8 | Sensor Integration and Calibration | 46 | Integrate sensors with the autonomous vehicle in simulation | 2 | Bilal (A)  Hamza (C)  Mohsin (I)  Usama (R) |
|  |  | 47 | Calibrate sensor data for accurate perception | 6 | Bilal (A)  Hamza (C)  Mohsin (R)  Usama (I) |
|  |  | 48 | Validate sensor data in simulated and real-world scenarios | 7 | Bilal (C)  Hamza (A/R)  Mohsin (R)  Usama (I) |
| 9 | System Integration | 49 | Integrate all software components into the autonomous vehicle system | 5 | Bilal (I)  Hamza (R)  Mohsin (C)  Usama (A/R) |
| 10 | Simulated Testing | 50 | Conduct comprehensive testing | 6 | Bilal (I)  Hamza (A/R)  Mohsin (C)  Usama (R) |
|  |  | 51 | Iterate on software development based on testing feedback | 2 | Bilal (R)  Hamza (I)  Mohsin (A)  Usama (C) |
|  |  | 52 | Fine-tune algorithms and software based on testing results | 3 | Bilal (C)  Hamza (A/R)  Mohsin (R)  Usama (I) |
| 11 | Optimization and Finalization | 53 | Optimize software performance and efficiency | 2 | Bilal (C)  Hamza (R)  Mohsin (A)  Usama (I) |
|  |  | 54 | Address any remaining issues or bugs | 1 | Bilal (I)  Hamza (C)  Mohsin (R)  Usama (A/R) |
|  |  | 55 | Finalize the project documentation and deliverables | 2 | Bilal (A/R)  Hamza (C)  Mohsin (C)  Usama (C) |