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)