Q.4	i.	What are the roles of the input layer, hidden layers and output layer?	**3**	1	4	3	1,2
	ii.	Discuss the optimization process in training neural networks. What is Stochastic Gradient Descent (SGD). How does it differ from traditional gradient descent?	**7**	2	2	3	1,2
OR	iii.	Describe the key components of Convolutional Neural Networks (CNNs) and their functions. How do convolutional and pooling layers work together to extract features from images and what are the advantages of using CNNs for image recognition tasks?	**7**	3	2	3	1,2
Q.5	i.	Explain the difference between intrinsic and extrinsic camera calibration.	**4**	1	2	4	1,2
	ii.	Discuss the role of Convolutional Neural Networks (CNNs) in 2D object detection and semantic segmentation.	**6**	2	4	4	1,2
OR	iii.	Describe the process of motion planning in autonomous vehicles.	**6**	3	4	4	1,2
Q.6		Attempt any two:					
	i.	Discuss the various constraints that must be considered during motion planning for autonomous vehicles.	**5**	2	5	5	1,2
	ii.	Explain the role of occupancy grids in representing the environment for autonomous driving.	**5**	2	7	5	1,2
	iii.	Compare and contrast Dijkstra's Shortest Path Search and A* Shortest Path Search algorithms.	**5**	3	2	5	1,2

******

Total No. of Questions: 6 *Total No. of Printed Pages:4*

Enrollment No.....

Faculty of Engineering
End Sem Examination Dec 2024
RA3EL18 Autonomous Vehicles

Programme: B.Tech. Branch/Specialisation: RA

Duration: 3 Hrs. **Maximum Marks: 60**

Note: All questions are compulsory. Internal choices, if any, are indicated. Answers of Q.1 (MCQs) should be written in full instead of only a, b, c or d. Assume suitable data if necessary. Notations and symbols have their usual meaning.

			Marks	**BL**	**PO**	**CO**	**PSO**
Q.1	i.	Which of the following is a commonly used method for state estimation and localization in autonomous vehicles? (a) Kalman filter (b) Particle filter (c) Least squares (d) All of these	**1**	1	2	1	1,2
	ii.	In vehicle modeling and control, what is the primary purpose of safety frameworks? (a) To improve fuel efficiency (b) To ensure compliance with industry standards and regulations (c) To enhance the vehicle's aesthetic design (d) To reduce manufacturing costs	**1**	1	2	1	1,2
	iii.	Which of the following sensors is commonly used in vehicle localization to provide high-accuracy positioning data? (a) Camera (b) GPS (c) Speedometer (d) LIDAR	**1**	2	4	2	1,2
	iv.	What is the primary advantage of using an Extended Kalman Filter (EKF) over a standard Kalman Filter in vehicle state estimation? (a) It can handle non-linear models (b) It requires less computational power (c) It is simpler to implement (d) It provides exact solutions for all cases	**1**	1	4	2	1,2

v.	Which of the following is the primary purpose of the backpropagation algorithm in a neural network? (a) To optimize the network's architecture (b) To adjust the weights of the network based on the error (c) To visualize the layers of the network (d) To reduce the complexity of the model	**1**	2	2	3	1,2	
vi.	In the architecture of Convolutional Neural Networks (CNNs), what is the main function of the pooling layer? (a) To increase the dimensionality of the data (b) To reduce the spatial dimensions of the feature maps (c) To add non-linearity to the model (d) To initialize the weights of the network	**1**	2	4	3	1,2	
vii.	In the pinhole camera model, which of the following describes the relationship between the 3D world coordinates and the 2D image coordinates? (a) Linear transformation (b) Non-linear transformation (c) Projective transformation (d) Affine transformation	**1**	1	6	4	1,2	
viii.	What is the primary purpose of intrinsic camera calibration? (a) To determine the position of the camera in the world (b) To measure the camera's optical properties and distortion (c) To enhance image resolution (d) To synchronize multiple cameras	**1**	1	6	4	1,2	
ix.	What is the primary purpose of using occupancy grids in motion planning for autonomous vehicles? (a) To enhance vehicle speed (b) To represent the environment in a discrete manner for obstacle detection	**1**	1	2	5	1,2	

		(c) To optimize fuel consumption (d) To improve passenger comfort						
	x.	Which algorithm is typically used to find the shortest path in a weighted graph that considers both the distance and cost associated with traversing edges? (a) Breadth-first search (b) Dijkstra's algorithm (c) Genetic algorithm (d) Hill climbing	**1**	2	4	5	1,2	
Q.2	i.	Discuss the key design considerations that must be taken into account when developing a vehicle control system.	**2**	2	2	1	1,2	
	ii.	Explain the importance of safety assessments in the automotive industry.	**3**	2	4	1	1,2	
	iii.	Describe the common hardware components used in vehicle control systems. How do these components interact with the software stack to achieve effective vehicle modeling and control?	**5**	3	4	1	1,2	
OR	iv.	Analyze the concept of least squares estimation in the context of state estimation and localization. What are its advantages and limitations in real-time vehicle applications?	**5**	4	5	1	1,2	
Q.3	i.	Explain the role of Inertial Measurement Units (IMUs) in vehicle localization.	**2**	1	2	2	1,2	
	ii.	Discuss the Iterative Closest Point (ICP) algorithm and its application in LIDAR scan matching for vehicle localization. What are the key steps involved in the ICP algorithm? What factors can affect its performance?	**8**	2	6	2	1,2	
OR	iii.	Describe the concept of multiple sensor fusion in vehicle state estimation. What are the benefits of integrating data from different sensors (e.g., GPS, IMU, LIDAR) for accurate localization, and what techniques can be used to achieve effective sensor fusion?	**8**	3	7	2	1,2	

Marking Scheme

RA3EL18Autonomous Vehicle

Q.1	i)	**D) All of the above**	**1**
	ii)	**B) To ensure compliance with industry standards and regulations**	**1**
	iii)	**B) GPS**	**1**
	iv)	**A) It can handle non-linear models.**	**1**
	v)	**B) To adjust the weights of the network based on the error**	**1**
	vi)	**B) To reduce the spatial dimensions of the feature maps**	**1**
	vii)	**C) Projective transformation**	**1**
	viii)	**B) To measure the camera's optical properties and distortion**	**1**
	ix)	**B) To represent the environment in a discrete manner for obstacle detection**	**1**
	x)	**B) Dijkstra's Algorithm**	**1**

Q.2	i.	Discuss the key design considerations that must be taken into account when developing a vehicle control system.	**2**
	ii.	Explain the importance of safety assessments in the automotive industry.	**3**
	iii.	Describe the common hardware components used in vehicle control systems.	**2**
		How do these components interact with the software stack to achieve effective vehicle modeling and control?	**3**
OR	iv.	Analyze the concept of least squares estimation in the context of state estimation and localization.	**3**
		What are its advantages and limitations in real-time vehicle applications?	**2**
Q.3	i.	Explain the role of Inertial Measurement Units (IMUs) in vehicle localization.	**2**
	ii.	Discuss the Iterative Closest Point (ICP) algorithm and its application in LIDAR scan matching for vehicle localization.	**4**
		What are the key steps involved in the ICP algorithm, and what factors can affect its performance?	**4**
OR	iii.	Describe the concept of multiple sensor fusion in vehicle state estimation.	**3**
		What are the benefits of integrating data from different sensors (e.g., GPS, IMU, LIDAR) for accurate localization, and what techniques can be used to achieve effective sensor fusion?	**5**
Q.4	i.	What are the roles of the input layer, hidden layers and output layer?	**3**
	ii.	Discuss the optimization process in training neural networks.	**3**
		What is Stochastic Gradient Descent (SGD), and how does it differ from traditional gradient descent?	**4**
OR	iii.	Describe the key components of Convolutional Neural Networks (CNNs) and their functions.	**3**
		How do convolutional and pooling layers work together to extract features from images and what are the advantages of using CNNs for image recognition tasks?	**4**
Q.5	i.	Explain the difference between intrinsic and extrinsic camera calibration.	**4**
	ii.	Discuss the role of Convolutional Neural Networks (CNNs) in 2D object detection and semantic segmentation.	**6**
OR	iii.	Describe the process of motion planning in autonomous vehicles.	**6**
Q.6		Attempt any two:	
	i.	Discuss the various constraints that must be considered during motion planning for autonomous vehicles.	**5**
	ii.	Explain the role of occupancy grids in representing the environment for autonomous driving.	**5**
	iii.	Compare and contrast Dijkstra's Shortest Path Search and A* Shortest Path Search algorithms.	**5**

P.T.O.

[2]

[3]

******

P.T.O.