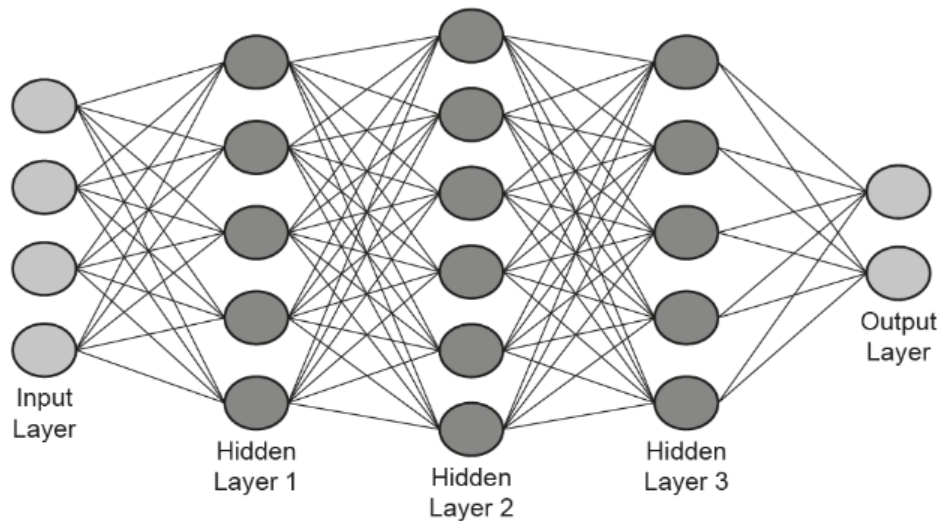9 **(a)** The diagram shown represents an artificial neural network.

(i) State the reason for having multiple hidden layers in an artificial neural network.

....

.... [1]

(ii) Explain how artificial neural networks enable machine learning.

....

....

(i) The reason for having multiple hidden layers in an artificial neural network, which is often referred to as a deep neural network, is to enable the network to capture complex features from the input data. Each hidden layer can potentially learn different levels of abstraction. For example, in image processing, the first hidden layer might learn to detect edges, the second hidden layer could learn to detect shapes, and further layers might detect more complex structures like objects or faces. This hierarchical learning makes deep neural networks particularly good at handling very complex tasks, such as speech recognition, image recognition, and natural language processing, where simpler models might fail to capture the depth of relationships within the data.

(ii) Artificial neural networks enable machine learning by providing a flexible framework for learning patterns from data. They consist of interconnected nodes (neurons) that work together to transform input data into outputs. The learning occurs when the network adjusts the weights of the connections between neurons through a process called backpropagation, which uses gradient descent to minimize the error between the predicted and actual outputs. By doing so, neural networks can learn to perform a

wide variety of tasks without being explicitly programmed to do so, effectively allowing them to develop their own 'rules' or 'logic' based on the patterns they detect in the training data. This capability to learn from examples and improve over time is what makes artificial neural networks a powerful tool in machine learning.

SHORT ANSWERS:
(i) Multiple hidden layers in an artificial neural network: They allow the network to learn complex patterns by creating hierarchical levels of feature representation and abstraction.

(ii) How artificial neural networks enable machine learning: Neural networks learn to make predictions by adjusting connection weights between neurons based on the data during the training process, allowing the model to improve and make informed decisions without being explicitly programmed for specific tasks.

Machine learning category

Machine learning category	Description
Supervised learning	simulates the data-processing capabilities of the human brain to make decisions
Reinforcement learning	enables learning by mapping an input to an output based on example input–output pairs
Deep learning	enables information related to errors produced by the neural network to be transmitted
Unsupervised learning	enables learning in an interactive environment by trial and error using its own experiences
	enables learning by allowing the process to discover patterns on its own that were previously undetected

- Supervised Learning: Enables learning by mapping an input to an output based on example input–output pairs.

- Reinforcement Learning: Enables learning in an interactive environment by trial and error using its own experiences.

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- Unsupervised Learning: Enables learning by allowing the process to discover patterns on its own that were previously undetected.