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END Semester Examination QP for subject AI & ML for Mechanical Engineers at COEP Technological University Pune Set B

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COLLEGE OF ENGINEERING, PUNE

(An Autonomous Institute of Government of Maharashtra)

END Semester Examination

Programme: Final Year B.Tech | **Semester: VIII**

Course Name: AI & ML for Mechanical Engineers | **Course Code: ME(DE)-22016**

Branch: Mechanical Engineering | **Academic Year: 2022-23**

Duration: 3 hours | **Max Marks: 60**

Student PRN No.

Instructions:

- Figures to the right indicate the full marks.
- Mobile phones and programmable calculators are strictly prohibited.
- Writing anything on question paper is not allowed.
- Exchange/Sharing of stationery, calculator etc. not allowed.

		Mrk	PO	CO
Q.1	A decision tree classifier is to be trained for classifying the type of gear based on input features: material, pressure angle, no. of teeth, pitch diameter (mm), face width (mm), and hardness. • Observe the dataset; identify discrete and continuous attributes along with their features. • Calculate information gain of attribute 'material' & 'hardness'. • Compare them and comment on which one of these two is suitable for the best split.	6	1, 2, 3, 4, 5, 8	1, 2, 3, 5

Training data

Material	Pressure angle	No. of teeth	Pitch Diameter (mm)	Face Width (mm)	Hardness	Gear Type
Steel	20°	24	48	20	Medium	Spur
Brass	14.5°	30	60	25	Hard	Helical
Plastic	20°	16	48	15	Soft	Bevel
Steel	14.5°	18	36	18	Medium	Spur
Brass	20°	28	84	30	Hard	Helical
Plastic	20°	14	42	12	Soft	Bevel
Brass	20°	22	44	22	Medium	Helical
Steel	14.5°	20	40	16	Hard	Spur
Plastic	20°	18	54	20	Soft	Bevel
Brass	20°	26	104	40	Hard	Helical

Q.2 Use PCA to find the principal components for a problem on an autonomous vehicle driving with the training data consisting of 4 attributes i.e. average speed (km/h), distance travelled (km), time spent accelerating (s), and time spent braking (s). 6 1, 2, 3, 4, 5 1, 2, 3, 5

Sample	Average speed (km/h)	Distance travelled (km)	Time spent accelerating (s)	Time spent braking (s)
0	80	10	50	20
1	75	12	40	30
2	85	8	60	10
3	90	15	45	15
4	70	11	55	25
5	95	13	35	5

Q.3 A dataset for a boiler system with 5 attributes (Temperature, Pressure, Fuel Type, Water Level, and Maintenance History) and 5 samples is shown below. 6 1, 2, 3, 4, 5 1, 2, 3, 5

Sample	Temperature	Pressure	Fuel Type	Water Level	Maintenance History
1	High	High	Gas	Low	Good
2	Medium	Medium	Oil	Medium	Average
3	Low	Low	Gas	High	Poor
4	High	Medium	Gas	Medium	Good
5	Medium	High	Oil	Low	Average

Using Bayes classifier, predict the probability of a new instance having the following attribute values as Temperature – High, Pressure – Medium, Fuel Type – Oil, Water Level – High, Maintenance History – Good.

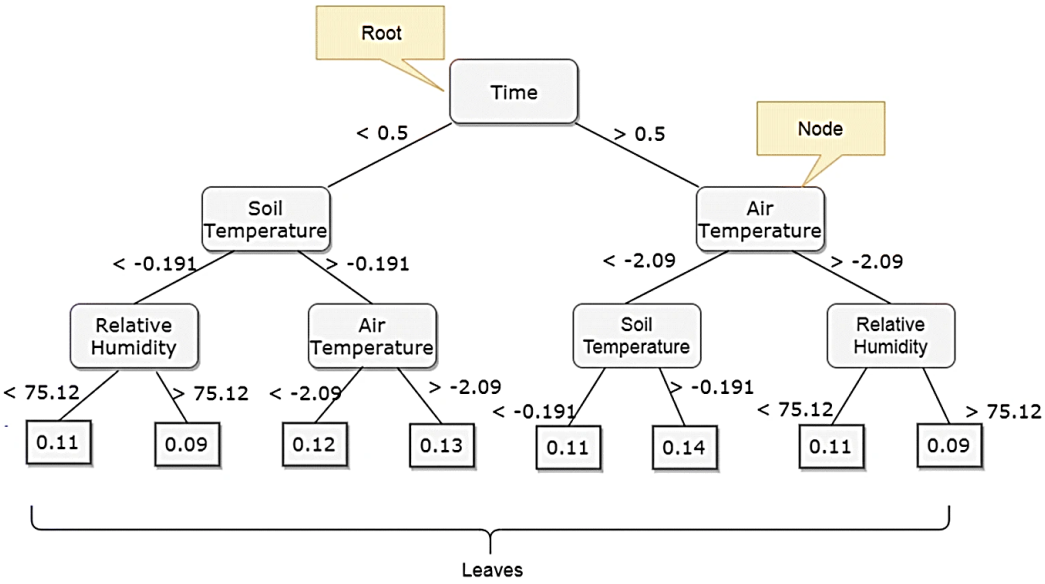
Q.4 A confusion matrix for a cutting tool faults classification is shown below. Calculate. 6 2 1, 2, 3, 5

- Correctly classified samples (considering all classes and per class)
- Incorrectly classified samples (considering all classes and per class)
- Overall accuracy of classification
- True positive, True negative, False positive, False negative, Precision, F1 Score

Actual					
Normal	*Flank wear*	*Nose wear*	*Notch wear*		
17	03	00	00	*Normal*	**Predicted**
02	***18***	00	00	*Flank wear*	
00	02	***18***	00	*Nose wear*	
00	00	00	***20***	*Notch wear*	

Q.5 Answer the following questions. 30 1, 1, 2, 2, 3, 3, 4, 5 5

A. How does following decision tree algorithm predicts soil moisture? Identify various nodes, attributes and features. Also, state whether it is regression problem or classification? Justify your answer.



B. Explain role of histograms for the following case. How do histogram features helpful to compare the performance? 5 1, 1, 2, 2, 3, 3, 4, 5 5

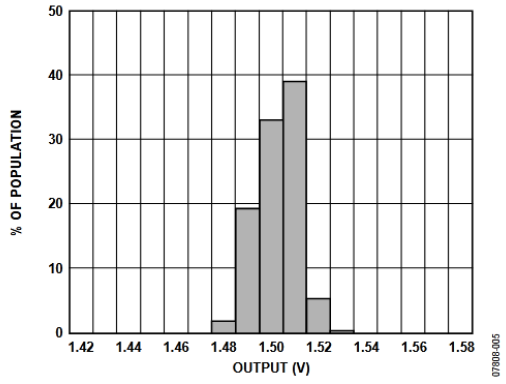


Figure 3. X-Axis Zero g Bias at 25°C, $V_S = 3$ V

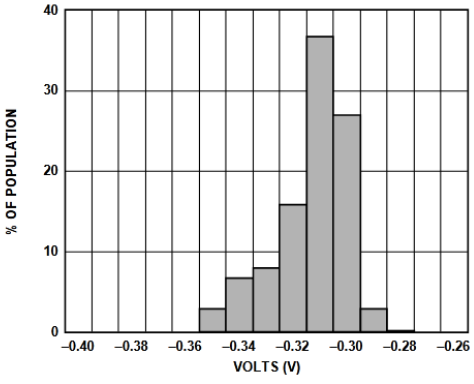


Figure 6. X-Axis Self-Test Response at 25°C, $V_S = 3$ V

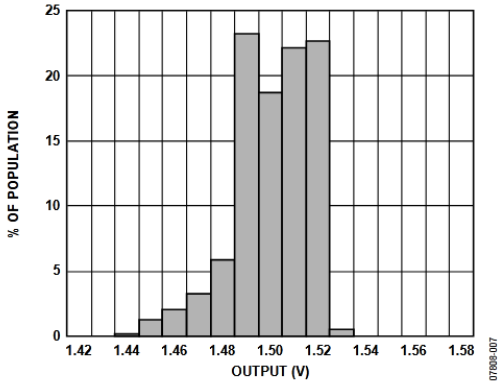


Figure 5. Z-Axis Zero g Bias at 25°C, $V_S = 3$ V

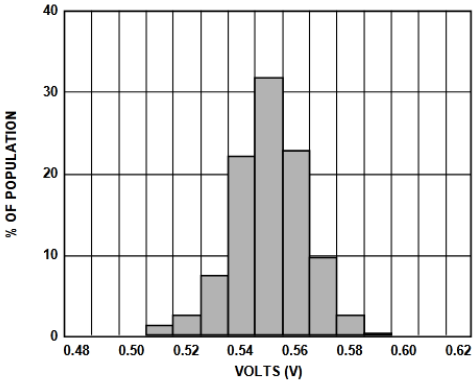


Figure 8. Z-Axis Self-Test Response at 25°C, $V_S = 3$ V

C.	How does bagging improve the performance of a single model in machine learning? What is its effect on bias and variance?	5	2	2, 3
D.	Suppose you need to develop AI-based recommender system for efficient management of Kumbh Mela considering following cases. • Personalized itinerary • Crowd management • Food recommendations • Navigation assistance • Health and Safety	5	1, 2, 3, 4, 5, 6, 7	1, 2, 3

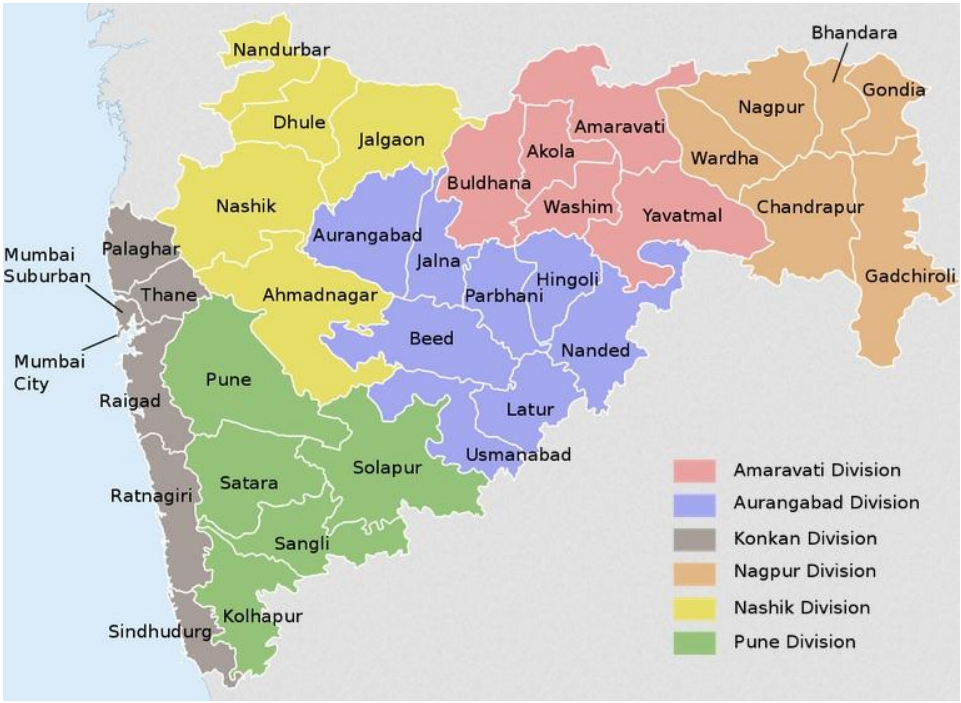
F. Match the hyperparameters with respect to their role in tuning ANN.

	5	2	2, 3

Hyperparameter	Role
1. Number of neurons	a. A weight is the amplification of input signals to a neuron and bias is an additive bias term to a neuron
2. Activation function	b. Defines how a neuron or group of neurons activate ("spiking") based on input connections and bias
3. Learning rate	c. Step length for gradient descent update
4. Batch size	d. No. of training examples in gradient descent update
5. Epochs	e. No. of times all training examples have been passed through the network during training
6. Loss function	f. Specifies how to calculate the error between prediction and label for a given training example
7. Major dimension	g. Number of input, output, and hidden layers
8. Regularization	h. Prevents overfitting in a neural network.

E.	Explain how value-based, policy-based, and model-based reinforcement learning can be applied in a simple scenario. Consider a robot in a room with two doors, door A and door B. The robot's goal is to reach a specific location in the room. The robot can take two actions: move forward or turn left. If the robot reaches the goal location, it receives a reward of +1, and if it collides with a wall, it receives a reward of -1.	5	2	4

Q.6	Answer in one line. **(Any 6)**	6		
A.	Compare scope of classification and clustering with respect to following picture.		2, 3, 5, 6	1, 2



B.	How many neurons are in the CNN output layer for classifying images into 5 classes?		2	1
C.	What is the shape of the output of the flatten layer in a CNN with the following architecture: Input layer (shape: 28x28x1), Convolutional layer (32 filters, kernel size: 3x3, padding: same, activation: ReLU), Max pooling layer (pool size: 2x2), Convolutional layer (64 filters, kernel size: 3x3, padding: same, activation: ReLU), Max pooling layer (pool size: 2x2), __ layer, Dense layer (128 neurons, activation: ReLU), Output layer (10 neurons, activation: softmax)?		2	4
D.	How many trainable parameters are in the entire CNN with the following architecture: Input layer (shape: 128x128x3), Convolutional layer (32 filters, kernel size: 3x3, padding: same, activation: ReLU), Max pooling layer (pool size: 2x2), Convolutional layer (64 filters, kernel size: 3x3, padding: same, activation: ReLU), Max pooling layer (pool size: 2x2), Flatten layer, Dense layer (128 neurons, activation: ReLU), Output layer (1 neuron, activation: sigmoid)?		2	4

E.	What is the output of a ReLU activation function when the input is -3.5?	2	4
F.	What is the derivative of the sigmoid function with respect to its input?	2	4
G.	What is the activation function used in the hidden layers of a deep neural network designed for a multiclass classification task?	2	4
H.	What is the margin of a linear SVM classifier for a data point that is correctly classified and has a distance of 2 from the decision boundary?	2	2
I.	What is the decision function of an SVM model with a linear kernel and the following coefficients and intercept: w = [1, -2, 3], b = 2?	2	2
J.	What is the effect of increasing the regularization parameter C in an SVM with a linear kernel?	2	2
K.	What is the root-mean-square error (RMSE) of a linear regression model for predicting the compressive strength of concrete, if its sum of squared errors on a validation set of 50 samples is 5000 MPa^2?	2	2
L.	What is the confusion matrix of a k-nearest neighbors (KNN) model for classifying the material type of a composite panel, if its test set has 50 samples, 30 of which are correctly classified as type A, 10 as type B, and 5 as type C?	2	2

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