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

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ABB

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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 to predict the likelihood of a vehicle rolling over during a sharp turn based on input features: vehicle speed during the turn (mph), angle of the turn (degrees), type of vehicle (e.g., sedan, SUV, pickup truck), weight (lbs), road surface conditions (e.g., dry, wet, icy), tire tread, driver behavior (e.g., aggressive, cautious).	6	1, 2, 3, 4, 5, 8	1, 2, 3, 5

- Observe the dataset; Identify discrete & continuous attributes along with their features.
- Calculate information gain of attribute 'Vehicle Type' & 'Road Surface'.
- Compare them and comment on which one of these two is suitable for the best split.

Speed (mph)	Turn Angle	Vehicle Type	Weight (lbs)	Road Surface	Tire Tread	Driver Behavior	Rollover
35	50°	SUV	4000	Wet	Good	Aggressive	Yes
25	30°	Sedan	3200	Dry	Good	Cautious	No
40	70°	Pickup	5000	Icy	Poor	Aggressive	Yes
30	45°	SUV	4500	Wet	Good	Cautious	No
50	80°	Pickup	5500	Dry	Good	Aggressive	Yes
20	20°	Sedan	2800	Dry	Good	Cautious	No
30	60°	SUV	4200	Wet	Good	Aggressive	Yes
40	75°	Pickup	5100	Icy	Poor	Cautious	Yes
35	55°	SUV	4100	Wet	Good	Cautious	No
45	90°	Pickup	5800	Dry	Good	Aggressive	Yes

Q.2 Use PCA to find the principal components of a heat transfer problem on a heat exchanger with the training data consisting of 4 attributes i.e. inlet temperature of fluid A, inlet temperature of fluid B, flow rate of fluid A and overall heat transfer coefficient.

Sample	Inlet temperature of fluid A (°C)	Inlet temperature of fluid B (°C)	Flow rate of fluid A	Overall HT coefficient
0	300	200	20	0.1
1	350	150	22	0.2
2	325	180	21	0.3
3	310	190	25	0.4
4	275	225	19	0.5
5	290	210	23	0.6

6 1, 1, 2, 2, 3, 3, 4, 5 5

Q.3 In dataset given below, there are 3 attributes – 'Location', 'Type of Solar Panel', and 'Efficiency' and 6 samples of different solar energy systems. Using Bayes classifier, calculate the probability of a solar panel being a Monocrystalline panel given that it has an efficiency of 0.18 and is installed at location California.

Sample	Type of Solar Panel	Efficiency	Location
1	Monocrystalline	0.18	California
2	Polycrystalline	0.16	Texas
3	Thin Film	0.14	Florida
4	Monocrystalline	0.18	New York
5	Polycrystalline	0.16	Ontario
6	Thin Film	0.14	Quebec

6 1, 1, 2, 2, 3, 3, 4, 5 5, 6, 7

Q.4 A confusion matrix for a cutting tool faults classification is shown below. Observe this matrix and calculate.

- 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

6 2 1, 2, 3, 5

| Actual				
Normal	Inner Race Fault	Outer Race Fault	Ball Fault	
140	00	00	00	Normal
00	**10**	05	00	Inner Race Fault
00	00	**20**	03	Outer Race Fault
00	00	02	**08**	Ball Fault

(Predicted)

Q.5 Answer the following questions.　30　1,　1,

A. How does following decision tree algorithm work for controlling combustion engine? Why is partial overlapping of drag start and hybrid drive observed in bottom center decision node? Also, identify various nodes, attributes and features.

2,　2,
3,　3,
4,　5
5
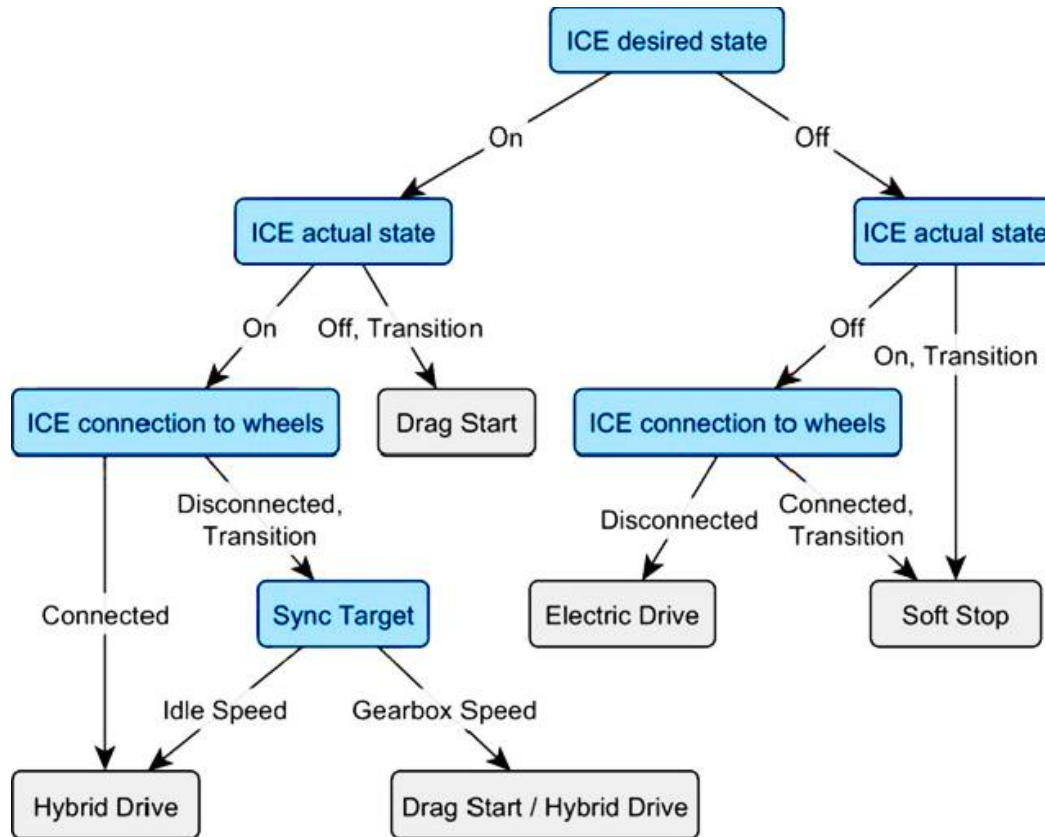
B. Following graphs represent change in vibration signal (in terms of acceleration) with respect to time that depicts 2 conditions i.e. healthy and faulty cutting tool.

5　1,　1,
2,　2,
3,　3,
4,　5
5
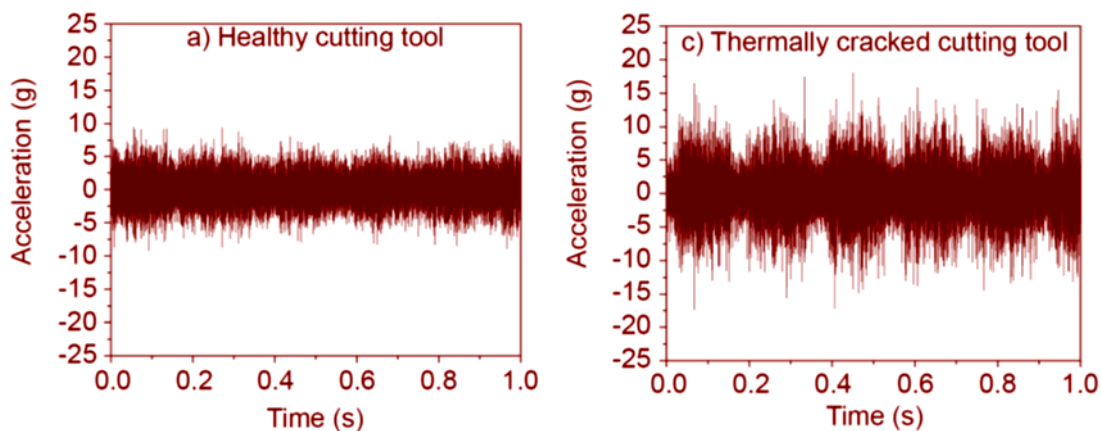
In order to develop machine learning based classification model, which statistical features will you extract from these vibration plots so as to depict difference between two. Draw a flowchart showing step by step procedure involved in developing classification model.

C. Compare bagging and boosting ensemble techniques. Does the Random forest tree algorithm fall into any of these categories? Justify. 5 2 2, 3

D. What is the scope of machine learning in this picture? 5 1, 2, 3, 4, 5, 6, 7 1, 2, 3

Clusters around 14 cities access 40 percent of the Indian market in 2030

INDIA EXAMPLE
★ Top 14 cities
● Other cities served

Criteria for creating clusters
- Economic factors
  − At least one hub city with GDP >$30 billion by 2030
  − Urban population in cluster not exceeding 50 million in 2030
- Efficiency factor
  − Distance: radius of not more than 500 km
- Consumer demographics
  − Age
  − Education
  − Other product-category-specific demographics such as media preference and attitude toward pricing[1]

10 clusters created around 14 cities. However, Delhi cluster becomes too large (population >60 million)

Delhi cluster is broken down into 2 more, resulting in 12 clusters

Due to proximity, following cities have been combined into one cluster
- Ahmedabad, Surat, Vadodara
- Mumbai, Pune
- Hyderabad, Vishakhapatnam
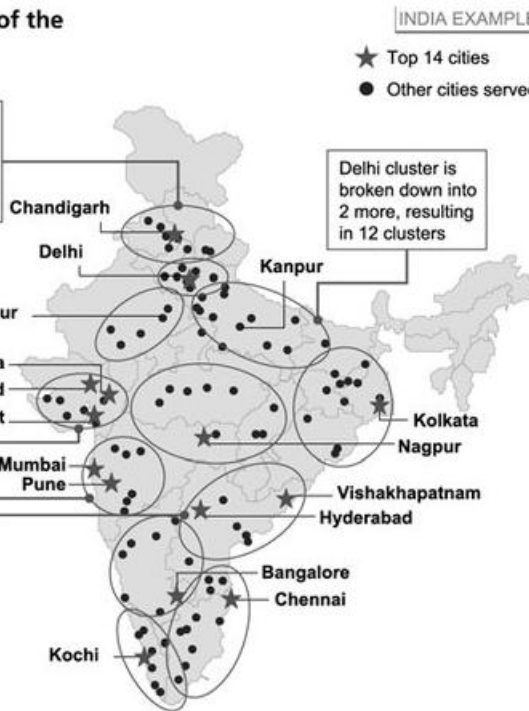
1 Not included.

F. Match the terms with respect to their role in reinforcement learning. 5 2 4

Term	Role
1. Agent	a. A situation in which an agent is present or surrounded by.
2. Environment	b. An entity that can perceive/explore the environment and act upon it
3. Action	c. A situation returned by the environment after each action taken by the agent.
4. State	d. The moves taken by an agent within the environment.
5. Reward	e. A strategy applied by the agent for the next action based on the current state.
6. Policy	f. A feedback returned to the agent from the environment to evaluate the action of the agent.
7. Value	g. An expected long-term retuned with the discount factor and opposite to the short-term reward.
8. Q-value	h. Takes one additional parameter as a current action

E.   What's the significance of these kernelized models in SVM based classification/ regression?   5   2   2, 3
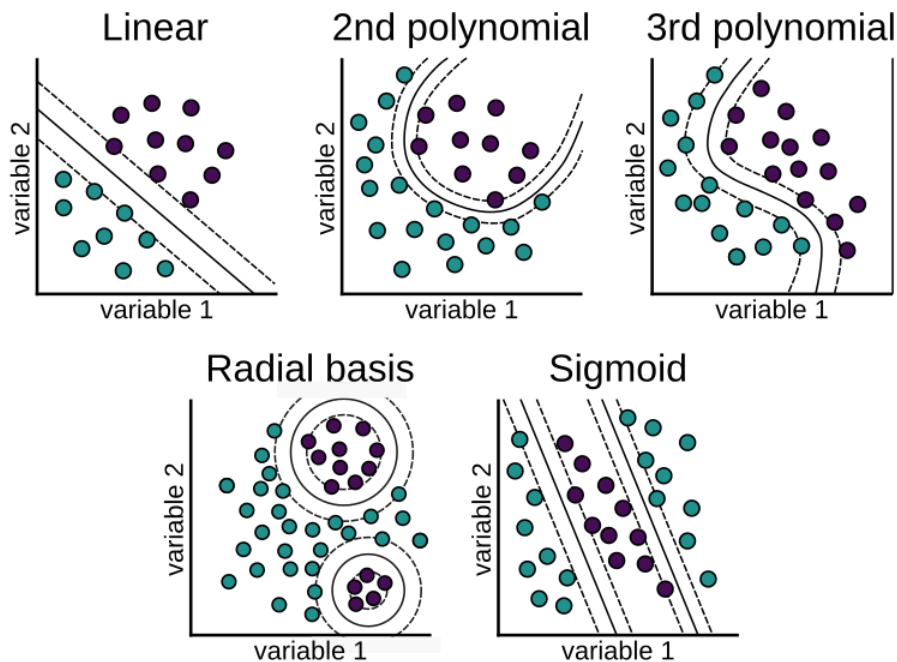
Q.6   Answer in one line. **(Any 6)**   6

A.   Which ML based technique will you recommend for Dahihandi task during Janmashtami? Justify your answer.   2, 3, 5,   1, 2

6

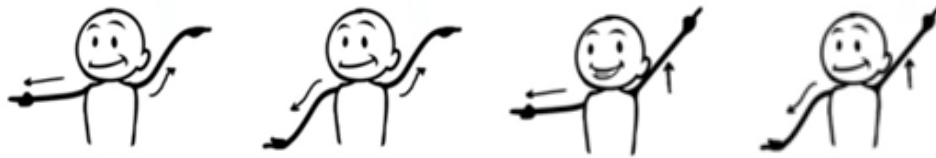B.   How does deep learning differ from shallow learning?   2   1

C.   How do neural networks work in deep learning?   2   4

D.	Draw a general labeled architecture of a Convolutional Neural Network.	2	4
E.	What's the use of Markov Decision process in reinforcement learning?	2	4
F.	Identify activation functions.	2	4

G.	Draw a flowchart showing steps in Q-leaning.	2	4
H.	What is the difference between KNN and K means?	2	2
I.	What is the maximum margin hyperplane for a dataset with 10 data points in a two-dimensional space using SVM?	2	2
J.	Given a dataset with 100 data points and 3 features, how many hyperplanes are there in a linear SVM with binary classification?	2	2
K.	What is the maximum number of support vectors in a binary SVM with 100 data points?	2	2
L.	Consider a dataset with three classes: red, blue, and green. Draw a scatter plot of the data points in a two-dimensional feature space, where the x-axis represents feature 1 and the y-axis represents feature 2. Suppose we want to train a support vector machine (SVM) to classify this data using both the one-vs-all and the one-vs-one multi-class strategies. Draw a diagram showing the decision boundaries and the support vectors for both strategies. Label the decision regions for each class and indicate which strategy is more suitable for this dataset.	2	2

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