Course Code: AI2002 BCS, BSE, BAI	Course Name: Artificial Intelligence
Instructor Name:	Dr Muhammad Farrukh / Dr Fahad / Saeeda Kanwal / Waheed Ahmed/ Sohail Afzal
Student Roll No:	Section No:

- Return the question paper.
- Read each question completely before answering it. There are **8 questions and 4 pages.**
- In case of any ambiguity, you may make assumption. But your assumption should not contradict with any statement in the question paper.
- All the answers must be solved according to the sequence given in the question paper.
- Be specific, to the point while coding, logic should be properly commented, and illustrate with diagram where necessary.

Time: **180 minutes.**   **Max Marks**: **50 points**

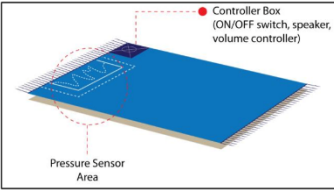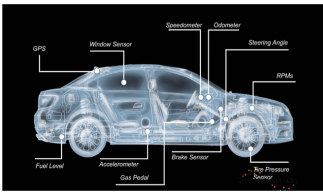| **Question No. 1**   CLO 1   [Time: 30 Mins] [Marks:(10)] |
|---|

A) Define the followings: [8]

1- Define AI agent.
2- What is back propagation and why do we use it?
3- How supervised and reinforcement learning are related?
4- Define the role of activation function and give the name of popular activation function.
5- Differentiate between Markov decision process and reinforcement learning.
6- Given the figure below, determine the followings:
   a) Whether A and B are conditionally independent given C is observable
   b) Whether A and B are conditionally independent given C is unobservable
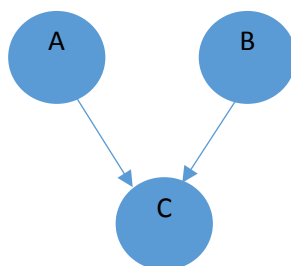
7- What is the concept of gradient decent in neural network?
8- Explain the difference between impurity and abnormality of a Dataset?

B) Complete the following Table. A: [2]

Applications	PEAS	Environment Type	Agent type
AI-enabled Prayer mat			
Ambulance drone			
AI-enabled smart shoes			
Autonomous car			

Question No. 2	CLO 3 [Time: 25 Mins] [Marks: (5)]

A dish antenna located at the ground station is receiving signals from the satellite for the news channels broadcasting. The satellite is launched in the low-earth orbit and consequently, the antenna looks angles (defined in degree) of the dish antenna need to be adjusted constantly to receive the maximum signals from the satellite. The following **Table.B** contains the values of the antenna look angles (in degree) that are taken by the dish antenna to adjust its location to receive the channels from the satellite.

Assume that a linear regression machine learning model is implemented to predict the channels correctly received from the satellite. Build a **Linear Regression Model** based on the value given in **Table. B**.

[Use to transform angles into the x and y coordinates, and radius = 10].

Table.B Channels and angle values

Channels	Angles (in degree)
A	34
B	45
C	55
D	48
E	49

Question No. 3   **CLO 3   [Time: 30 Mins] [Marks: (5+5)]**

a) The mobile users are receiving signals from the base station (Tower) for the communication purposes through wireless channel link. The wireless link is vulnerable to the various kind of abnormal attacks launched by the malicious node in a network. The mobile phones of a user's are equipped with the cognitive capabilities and can determine normal and abnormal transmission. Assume that the control unit (CU) inside a mobile phone of a user X receives signal values from the BS in terms of distance and power as shown in **Table. C** between *11:00 to 3:00 PM*. The CU is intelligent and can classify the signals based on distance and power levels. Use *KNN algorithm* with k = 3 to classify the signal **5**.

Table.C Mobile signal with respect to power and distance

Signals	*Distance*	*Power*	Class (Normal and Abnormal)
1	8	20	Normal
2	4	18	Normal
3	5	16	Abnormal
4	10	15	Normal
5	32	10	??

b) An ABC hospital collects the **COVID19** patient information at the time of the admission into the hospital for the registration purposes and further treatment processes. The form contains, the following information's: Patient name, date of birth, address, age, height body temperature, blood pressure and weight, cough etc. ABC hospital deploys Chatbot (name **Hosp-robo**) that can perceive the patient conditions based on the information provided during the registration and suggests whether to admit in the hospital or not. Moreover, it can predict the patient missing information based on the information contained in the form. Consider the following information given in a **Table. D** below and assume that Hosp-robo use simple prediction model for prediction purposes. Predict the weight of the patient **8th (Mr Saleem)** by using **Age** and **Height** information using any suitable algorithm.

Table. D Patient dataset

Patient Name	Address	Age	Body temperature	Height	Blood pressure	Cough	Respiratory Problem	Weight	Admitted to the hospital
Aslam	DHA	46	102	6	109	Yes	Severe	60	Yes
Umair	Malir	44	97	6.11	98	No	Less severe	55	No
Zain	Johar	36	99	5.9	85	No	Less severe	56	No
Umer	Gulshan	37	100	5.8	83	No	Severe	59	Yes
Ali	Saddar	39	97	5.3	95	No	Less severe	76	No
Ziauddin	Johar	40	98	5.6	120	Yes	Severe	78	Yes
Waqar	DHA	42	99	5.5	180	Yes	Less severe	80	No
Saleem	**Bahria town**	**44**	**102**	**5.8**	**110**	**Yes**	**Severe**	**??**	**Yes**

Question No. 4	CLO 3 [Time: 20 Mins] [Marks(2+4+4)]

A) Suppose you had a neural network with linear activation functions. That is, for each unit the output is some constant **c** times the weighted sum of the inputs. Assume that the network has one hidden layer. For a given assignment to the weights **w**, write down equations for the value of the units in the output layer as a function of **w** and the input layer **x**, without any explicit mention of the output of the hidden layer.

B). The spread spectrum (SS) has been a very popular technique to encode messages in military communication. In SS, a message signal is combined with the secret chip sequence using *XOR* operation. The resultant message is unable to decode by the unknown receiver and transmitted through wireless channel. Draw a simple **Neural Network Architecture** which can achieve the *XOR* operation of the following given data shown in **Table. E**.

Table.E Input and output values

Message signal: x1	Secret chip sequence: x2	Resultant message: y
0	0	0
1	1	0
1	0	1
0	1	1

C) A self-driving (SD) car is moving on a highway with the speed of 120 KM/ Hour. The SD car is equipped with the different kind of sensor such as LiDAR, RADAR, temperature sensors etc. LiDAR and RADAR sensors inputs inform the car about the nearby and at distance objects and car brakes system actuates if it detects objects near to the car.

The car autonomous system (AS) takes LiDAR and RADAR information as a sensory input and decides to actuate the brake system if the object is so closed to the car. Let's assume that AS unit of a car incorporates the neural network structure as shown in the **fig.1** below. The output neuron activates (produces high value) based on certain values of LiDAR and RADAR data if the object is too close to the car and eventually, brake system gets activated and car stops. Determine the value of output neuron **O** based on the given data as follows using only feedforward propagation and for 1 epoch. Use Sigmoid function = for all the activation functions.

LiDAR x1 = 3	RADAR x2 = -5	w11 =-0.33	w12 = -0.76	w13 = 0.22	b21 = 0.56	b22 = -0.1	b23 = 0.38
W31 = -0.8	W41 = 0.85	w51 = 0.17	b3 = -0.5	b4 = 0.3	b5= 0.6	b6= 0.25	b7= 0.1
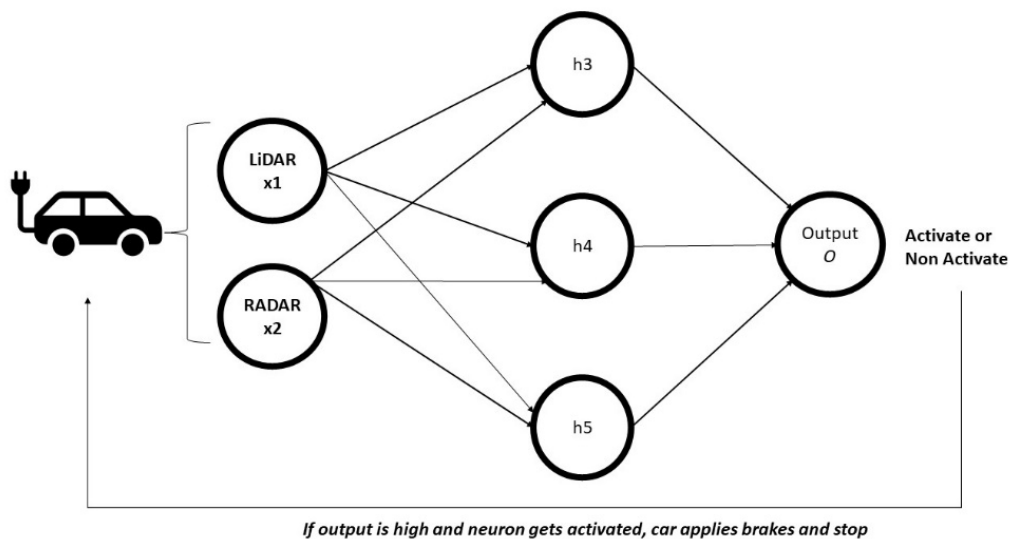
Figure. 1: Self-driving car braking system models as a neural network

a. Draw the **Bayesian Network** that corresponds to this conditional probability: P (A | B, C, E) P (B | D, E) P (C | F, H) P (D | G) P (E| G, H) P (F | H) P(G) P(H).

b. Calculate P(OS=PASS | ITC=PASS) using the network given below:

P(PASS)	0.4

OOP

P(FAIL)	0.4

DS

P(D=PASS|OOP,ITC)	0.2	OOP=PASS, ITC=PASS
	0.8	OOP=PASS, ITC=FAIL
	0.3	OOP=FAIL, ITC=PASS
	0.95	OOP=FAIL, ITC=FAIL

P(OS=FAIL|DS)	0.7	DS=PASS
	0.2	DS=FAIL

OS
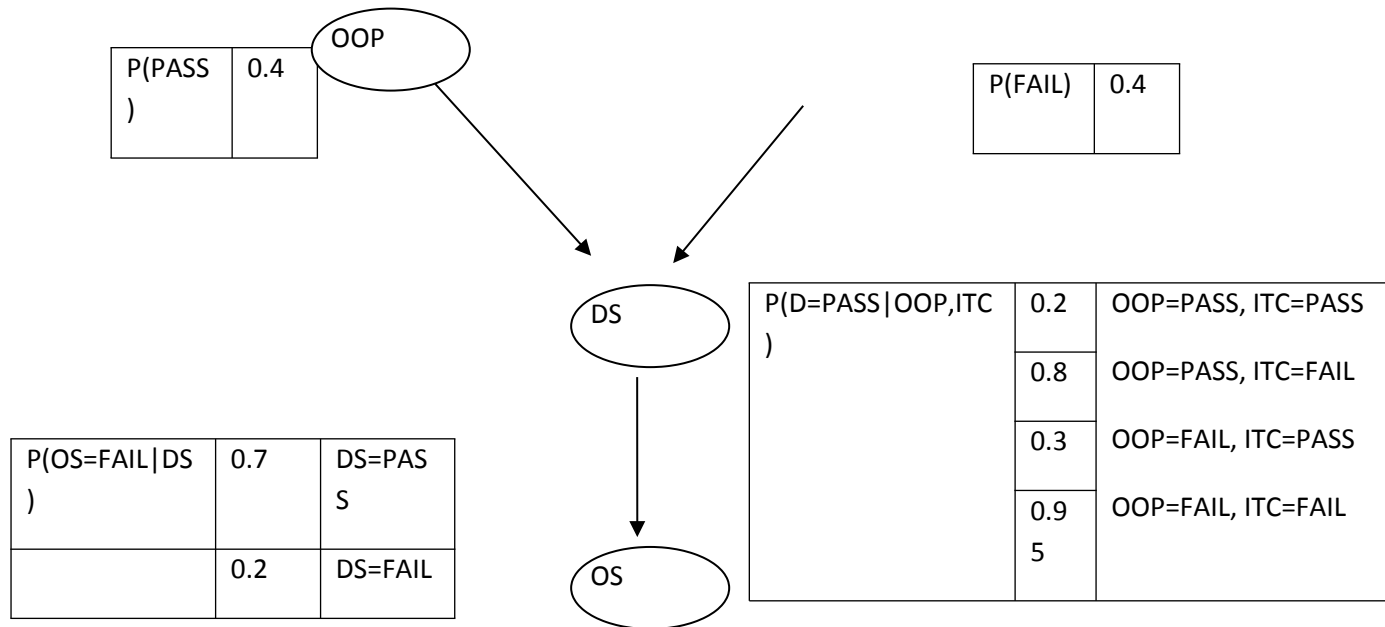
Determine the best possible learning method for the following applications given in **Table. F**. Write **APPLICABLE** infront of each application and write one line justification as well.

Table.F Different applications

Applications	Supervised LEARNING Methods With one line justification	Unsupervised Learning Methods With one line justification	Reinforcement Learning With one line justification
Hate Speech Detection			
Self-driving car			
Rescues robots			
Stock Market prediction			
Bank transaction fraud			

detection			

In this problem, the following dataset has been used to learn a decision tree which predicts that if students pass **Artificial Intelligence** course (Yes or No), based on their Study (**Yes, No**) and previous Grade (High, Medium, or Low).

Study	Grade	Pass
Yes	Low	Yes
No	Medium	No
No	Low	No
Yes	Medium	Yes
No	High	No
Yes	High	Yes

i. What is the entropy H(Pass)?

ii. What is the entropy H(Pass | Grade)?

iii. What is the entropy H (Pass | Study)?

iv. Which attribute would you consider as the root node? What was the information gain of the

attribute you chose as the root node?

v. Draw the decision tree.

Consider the following **Fig.2** giving the concept of AI-enabled IoT based city. Imagine yourself as a Data Scientist leading a team of AI scientist whose task is to develop an AI-enable smart city. To put things in perspective, describe in **10 points / steps** the necessary actions you will take to develop smart city. (For example, how you will collect dataset for different field of the city such as transportation, banking, education etc. Which AI technique you will use for education system, transportation, medical etc.)
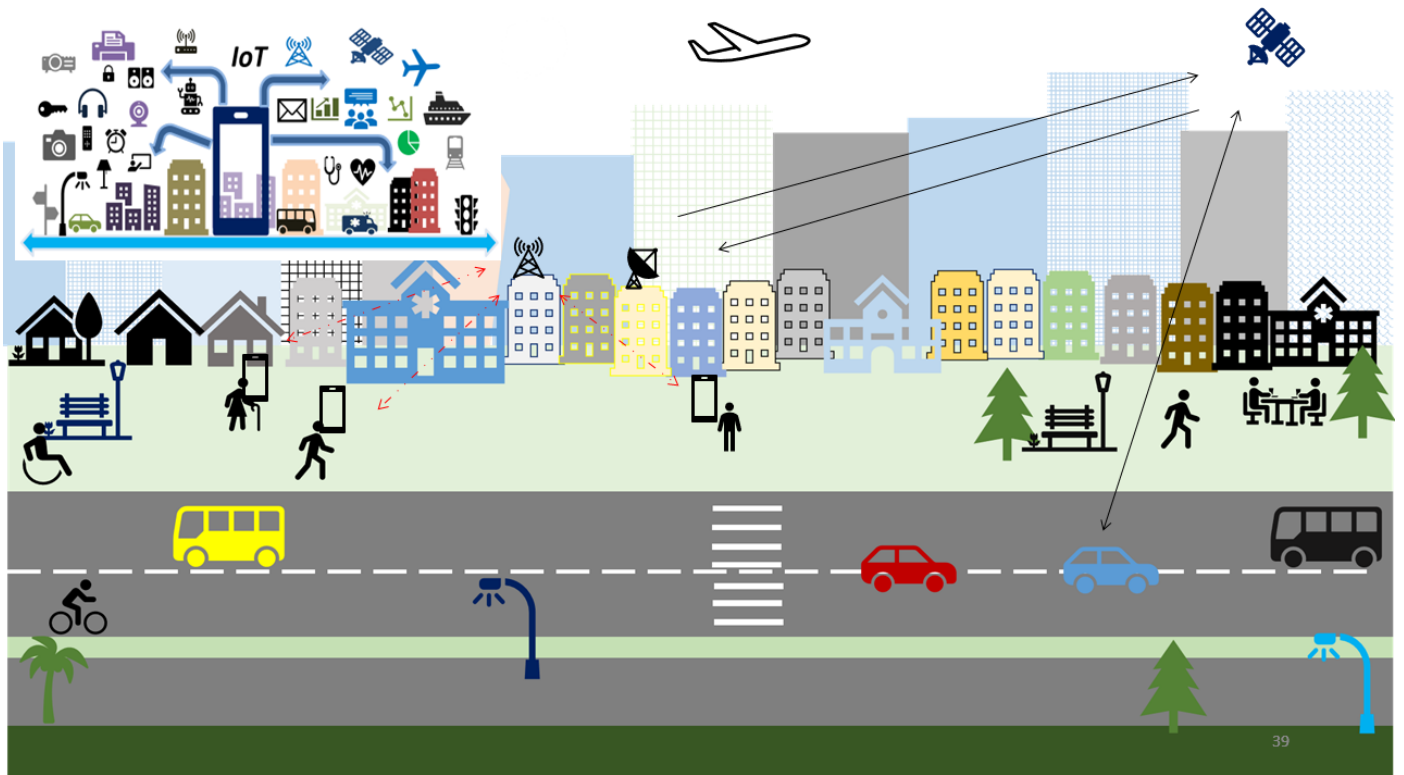
Figure. 2: AI-enabled smart city

Good Luck !