Tribhuvan University
Institute of Sciences and Technology
SCHOOL OF MATHEMATICAL SCIENCES
Second Assessment 2079

Subject: **Statistical Methods for Data Science** *Full Marks*: **45**

Pass Marks: **22.5**

Course No: **MDS 553** *Time*: **2 hrs**

Level: **MDS /I Year /II Semester**

Candidates are required to give their answer in their own words as far as practicable.

Group A **[5 ×3=15]**

1. If a probability is 0.40 that a child exposed to a certain disease will contain it, what is the probability that the tenth child exposed to the disease will be the third to catch it?
2. What do you understand by Extreme Value Distributions?
3. Discuss conjugate prior with its families.
4. What do you understand by unbiased test?
5. Show that exponential family distribution has MLR.

Group B **[5 × 6 = 30]**

6. Show that the negative Binomial Distribution is a special case of Generalized Power Series Distribution (GPSD).
7. Let x is distributed as a Poisson distribution with parameter λ and λ itself is distributed as a Gamma distribution with parameter α and β. Find the posterior distribution of λ given x. Also, calculate its mean and variance.,

OR

The time failure of transition is known to be exponential distribution with parameter λ. If the prior distribution of λ is exponentially distributed with parameter θ. Find the posterior distribution of λ given $x_1, x_2, \ldots x_n$. Also, compute its mean and variance.

8. Discuss Compound Negative Exponential Distribution. Derive its moments.
9. Let X has a mixed distribution with DF, F(x) defined as follows:

$$F(x) = \begin{cases} 0 & if\ x < 0 \\ \frac{x^2+1}{4} & if\ 0 \le x < 1 \\ \frac{x+2}{4} & if\ 1 \le x < 2 \\ 1 & if\ x \ge 2 \end{cases}$$

Obtain mean and variance of X and Sketch F(x) with respect to x.

10. Let a random variable has normal distribution with unknown 'μ' and known variance '2' i.e. X~N (μ, 2). Derive the Likelihood Ratio Test (LRT) for testing the null hypothesis H_0: μ=10 against H_1: μ≠10 at a 5% level of significance.

OR

Let $x_1, x_2, \ldots, x_n$ be a sample from $N(0, \sigma^2)$. Test the UMP test exist of not for testing a hypothesis H_0: $\sigma = \sigma_0$ against

a) H_0: $\sigma > \sigma_0$
b) H_0: $\sigma < \sigma_0$
c) H_0: $\sigma \neq \sigma_0$

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Second Assessment 2079

Subject: **Applied Machine Learning** *Full Marks*: **45**

Course No: **MDS 552** *Pass Marks*: **22.5**

Level: **MDS /I Year /II Semester** *Time*: **2 hrs**

Candidates are required to give their answer in their own words as far as practicable.

Group A **[5 ×3=15]**

1. Discuss about sensitivity and specificity metrics.
2. Explain R^2 metrics.
3. How dynamics of MDP proceeds? Explain.
4. Discuss value iteration algorithm briefly.
5. Discuss deterministic model of neuron.

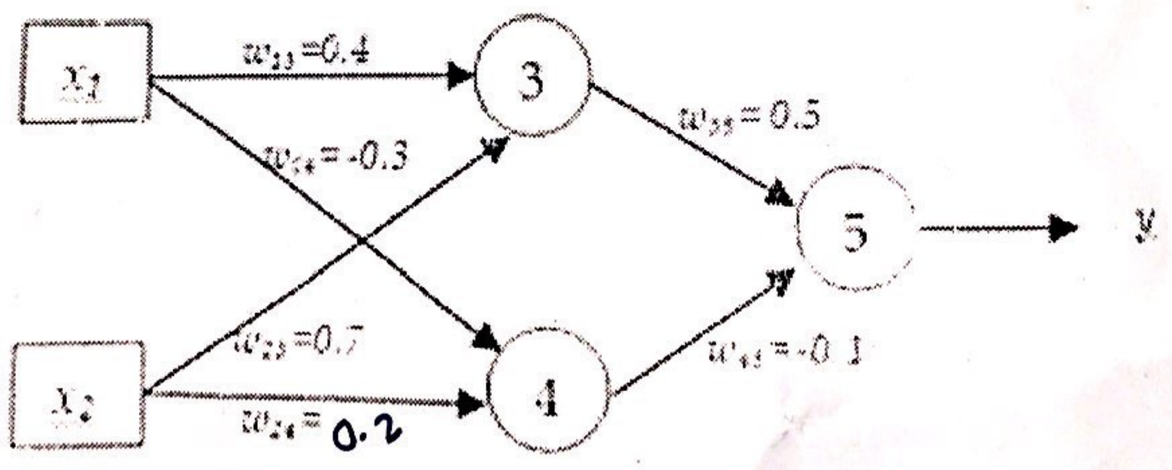
Group B **[5 × 6 = 30]**

6. What is perceptron? Derive weight update rule for perceptron.

OR

State XOR problem Can we realize XOR function using perceptron? If yes, realize it using perceptron. Otherwise, realize XOR function using MLP.

7. Consider a MLP given below. Let the learning rate be 0.7. The initial weights of the network are shown in the MLP. Assume that first training tuple is (1, 0) and its target output is 1. Calculate weight updates by using back-propagation algorithm. Assume logistic activation function.



8. Discuss working of RNN with suitable block diagram and mathematical formulation.
9. How soft clustering methods differs from hard clustering methods? Discuss working of EM algorithm for Gaussian mixture models.
10. Discuss working of hierarchical clustering algorithms.

OR

Divide the data points {(2,2),(4,3), (4,8),(6,6), (2,7), (3,1)} into two clusters using k-medoid algorithm.

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Second Assessment 2079

Full Marks: **45**

Pass Marks: **22.5**

Subject: **Programming with Python**

Time: **2 hrs**

Course No: **MDS 551**

Level: **MDS /I Year /II Semester**

Candidates are required to give their answer in their own words as far as practicable.

Group A **[5 ×3=15]**

1. Why do we need problem analysis before writing programs?
2. What is list type in python? Compare list with tuple?
3. Write a program in Python to test whether a number entered is prime or not.
4. what is recursive function? Write a recursive program to find factorial of a number.
5. Why function is important in programming? How do you create and use functions in Python?

Group B **[5 × 6 = 30]**

6. Explain each type of if statement in Python with example.

OR

How can you read and write files in Python? Explain reading and writing files with example.

7. Explain array broadcasting in NumPy with example. How do you search and sort arrays using NumPy?

OR

What is dictionary data type? Explain its uses with example. What is nested dictionary?

8. Why looping is important in programming? Explain both for and while loop with example.
9. Why pandas is important in Python programming? What is data frame? How do you handle missing data in data frame? Explain.
10. How can you draw multiple plots in one figure using pyplot ? Explain with example, how do you generate bar graphs and histograms using pyplot?

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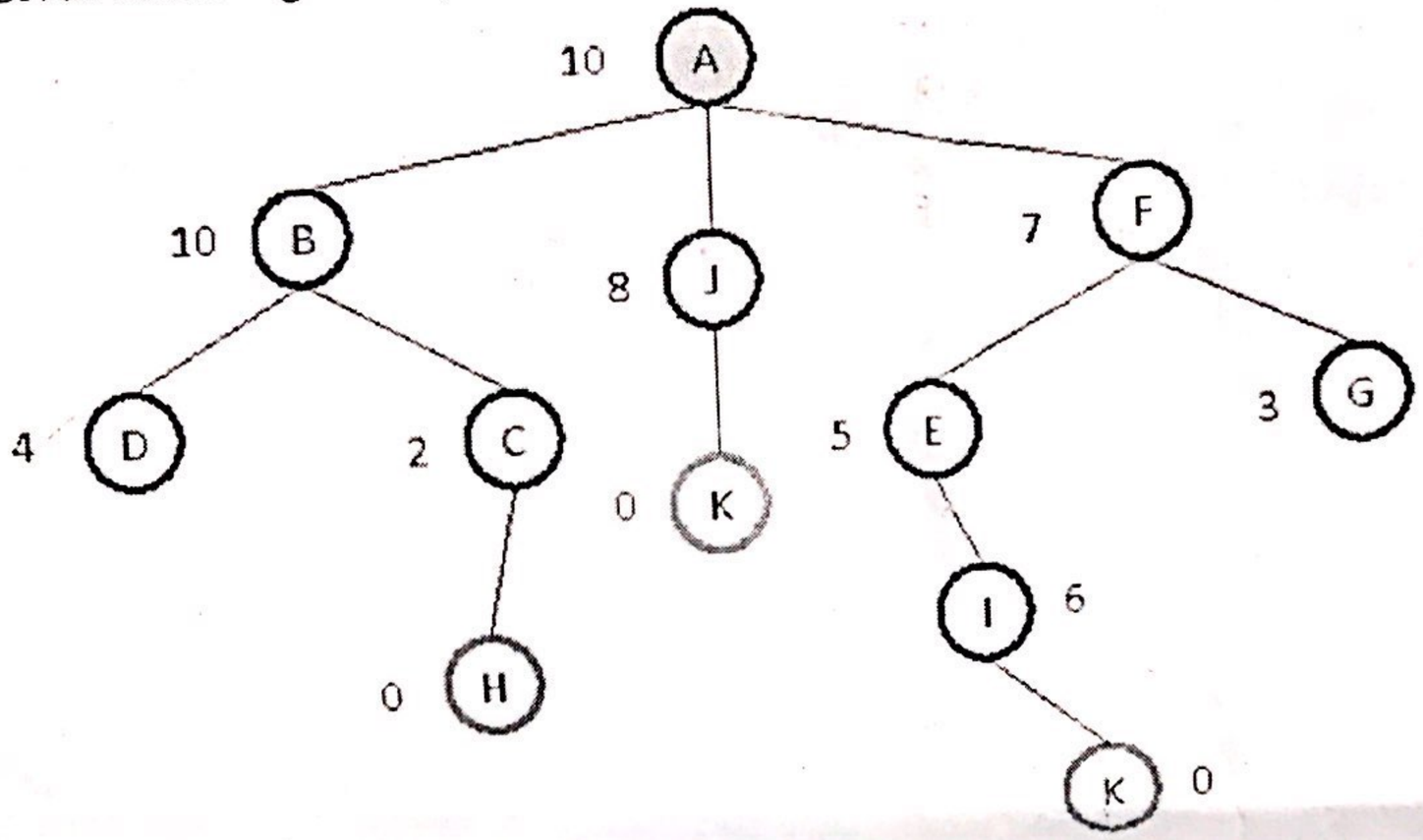
Full Marks: 45
Pass Marks: 22.5
Time: 2 hrs

Subject: **Artificial Intelligence**
Course No: **MDS 556**
Level: **MDS /I Year/II Semester**
Candidates are required to give their answer in their own words as far as practicable.
Attempt All Questions.

Group A [5 × 3 = 15]

1. How can you define AI from the dimension of acting rationally?
2. Justify with example how episodic environment of agent differs from the sequential environment.
3. Given following state space with start state=A, show how hill climbing search works.



4. What is the significance of pragmatic analysis in NLP?
5. Represent following knowledge using Frames;
   Ram is a student. His roll number is 15. The number of presence of Ram is 15 days. For every students, the marks for regularity is 10% of present days. Ram is enrolled in a course MDS. MDS is a course having 63 credits and it has total 19 courses.

Group B [5 × 6 = 30]

6. How searching approach of iterative deepening is different from depth limited search? Illustrate with appropriate examples. .

OR

How searching approach of DFS is different from BFS? Illustrate with suitable examples.

7. How predicates are converted into CNF form? Convert following into equivalent CNF.
   All girls are smart. Some boys are also smart. All boys who are smart are young. Some girl who is not young is not talent. All boys love girls. Height of all boys is greater than height of all girls.

OR

What is unification and lifting? Why it is important in resolution algorithm? Try to identify unifier or most general unifier for following;

Loves(Ram, Sita)	Loves(Hari, Sita)
Loves(X, Sita)	Loves(Ram,Y)
Loves(X, Sita)	Loves(Ram, X)
Loves(Ram, X)	Loves(Y,Z)

8. What is the significance of Kinematics in robotics? Differentiate direct kinematics from inverse.

9. Describe the various types of environments where agent can work.

10. Given following;

Age	Sex	Cholesterol_level	Chest_pain	Heart_Attack_risk
Old	Male	High	Yes	High
Old	Male	Desirable	No	Low
Young	Male	Borderline	No	Low
Young	Male	High	Yes	High
Young	Female	Desirable	Yes	Low
Old	Female	High	Yes	High
Old	Female	Borderline	No	Low

Predict the heart attack risk using Naïve Bayes model for the instance having Age=Old, Sex=Male, Cholesterol=Borderline, Chest_pain=Yes.

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Second Assessment 2079

Subject: **Multivariable Calculus for Data Science** *Full Marks*: 45
Course No: **MDS 554** *Pass Marks*: 22.5
Level: MDS/I **Year /II Semester** *Time*: 2 hrs

Candidates are required to give their answer in their own words as far as practicable.

Attempt All Questions.

Group A [5 × 3 = 15]

1. Find the normal vector and binormal vector of the space curve $\vec{r} = x\vec{i} + y\vec{j} + z\vec{k}$ where $x = t^2, y = t^2, z = t^3$ at point (1, 1, 1).

2. Evaluate $\iint_D (10x^2y^3 - 6)\, dA$, where D is the region bounded by $x = -2y^2$ and $x = y^3$.

3. Evaluate $\iiint_E (12y - 8x)\, dV$ where E is the region behind $y = 10 - 2z$ and in front of the region in the xz-plane bounded by $z = 2x$, $z = 5$ and $x = 0$.

4. If $\vec{F} = (2x + y)\vec{i} + (3y - x)\vec{j}$, evaluate the line integral $\int_C \vec{F} \cdot d\vec{r}$ where C is the curve in the xy-plane consisting of the straight lines from (0, 0) to (2, 0) and then to (3, 2).

5. If a closed surface S enclosed a volume V and $\vec{F} = x\vec{i} + 2y\vec{j} + 3z\vec{k}$, Using Gauss' theorem show that $\iint_S \vec{F} \cdot \vec{n}\, ds = 6V$.

Group B [5 × 6 = 30]

6. *Find the maximum and minimum values of* $f(x, y, z) = y^2 - 10z$ subject to the constraint $x^2 + y^2 + z^2 = 36$.

OR

The plane $x + y + 2z = 2$ intersects the paraboloid $z = x^2 + y^2$ in an ellipse. Find the points on this ellipse that are nearest to and farthest from the origin.

7. a) Use a double integral to determine the volume of the solid that is inside the cylinder $x^2 + y^2 = 16$, below $z = 2x^2 + 2y^2$ and above the xy-plane.

b) Use a triple integral to determine the volume of the region below $z = 6 - x$, above $z = -\sqrt{4x^2 + 4y^2}$ inside the cylinder $x^2 + y^2 = 3$ with $x \leq 0$.

8. a) Evaluate $\iint_R (x + 2y)\, dA$ where R is the triangle with vertices (0, 3), (4, 1) and (2, 6) using the transformation $x = \frac{1}{2}(u - v), y = \frac{1}{4}(3u + v + 12)$ to R.

b) Determine the surface area of the portion of $y = 2x^2 + 2z^2 - 7$ that is inside the cylinder $x^2 + z^2 = 4$.

9. Define line integral. Is the the vector field $\vec{F} = (x^2 - yz)\vec{i} + (y^2 - zx)\vec{j} + (z^2 - xy)\vec{k}$ a irrigational? Justify. Also find a scalar function ø such that $\vec{F} = \nabla ø$.

OR

State Green's theorem in the plane. Prove that the area enclosed by a simple closed curve C is given by $= \frac{1}{2}\int_C (x\, dy - y dx)$. Verify Green's theorem in the plane for $\int_C (2xy - x^2)\, dx + (x + y^2)\, dy$ where C is the closed curve given by $y = x^2, x^3 = y^2$.

10. State Stokes' theorem in a surface S. Show that in a plane, Green's theorem is a particular case of Stokes' theorem. Verify Stokes' theorem for the vector function $\vec{F} = (x^2 + y^2)\,\vec{i} - 2xy\,\vec{j}$ taken round the rectangle in the xy-plane bounded by $x = 0, x = a, y = 0, y = b$.

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