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# B.M.S. College of Engineering, Bengaluru-560019

**Autonomous Institute Affiliated to VTU**

## October 2024 Supplementary Examinations

**Programme: B.E.** **Semester: VI**
**Branch: Artificial Intelligence and Machine Learning** **Duration: 3 hrs.**
**Course Code: 24AM6HSSMM** **Max Marks: 100**
**Course: Stochastic Modelling for Machine Learning**

**Instructions**: 1.Answer any FIVE full questions, choosing one full question from each unit.
2. Missing data, if any, may be suitably assumed.

**Important Note:** Completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages. Revealing of identification, appeal to evaluator will be treated as malpractice.

| | | **UNIT - I** | ***CO*** | ***PO*** | **Marks** |
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| 1 | a) | List the types of stochastic process classified on the basis of relationship among the random variables. Describe any two of them. | *CO1* | *PO1* | **5** |
| | b) | Illustrate any three properties of the following:<br>i. Symmetric random walk<br>ii. Scaled symmetric random walk | *CO2* | *PO3* | **10** |
| | c) | If a person borrowed $500 for an annual interest rate 12%, Calculate the total amount the person has to repay at the end of the year if interest is compounded for the following:<br>i. Quarterly<br>ii. Semi yearly | *CO2* | *PO3* | **5** |
| | | **UNIT - II** | | | |
| 2 | a) | Consider a machine that can be in one of two states: working or failed. If it's in the working state on day n, it remains in the working state with probability 'u' on day n+1, regardless of its past behaviour. Similarly, if it's in the failed state on day n, it stays in the failed state on day n+1 with probability 'd' regardless of its past behaviour. Let $X_n$ denote the state of the machine on $n^{th}$ day. For the given model provide:<br>i.Transition Probability Matrix<br>ii. Directed Graph | *CO3* | *PO4* | **4** |
| | b) | Derive the Chapman-kolmogorov equation. Also describe the mathematical notations associated in it. | *CO2* | *PO3* | **6** |
| | c) | For the given Transition Probability Matrix: | *CO2* | *PO2* | **10** |

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| | | | $T = \begin{pmatrix} 0.4 & 0.2 & 0.4 \\ 0.3 & 0.1 & 0.6 \\ 0.5 & 0.4 & 0.1 \end{pmatrix}$ and the provided initial distribution is:<br>$P(X_0=1)=0.3$; $P(X_0=2)=0.6$; $P(X_0=3)=0.1$.<br>i. Compute the distribution of $X_1$ and probabilities for<br>$P(X_4=1, X_3=2, X_1=1, X_2=3, X_5=1 \| X_0=2)$ and<br>$P(X_1=1, X_3=1, X_4=3 \| X_0=2)$.<br>ii. Compute the steady state probability. | | | |
| | | | **UNIT - III** | | | |
| | 3 | a) | If $f_{kk}^{(n)} = \frac{n}{2^{n+1}}$ , n=1, 2, 3,………….. Analyze whether the state k is recurrent or not. | *CO3* | *PO2* | **5** |
| | | b) | Write the basic limit theorems for periodic and aperiodic Markov. | *CO1* | *PO2* | **5** |
| | | c) | Consider the following Transition Probability Matrix:<br>$P = \begin{pmatrix} 0.1 & 0.3 & 0.2 & 0.2 & 0.2 \\ 0.3 & 0.1 & 0.2 & 0.2 & 0.2 \\ 0.0 & 0.0 & 0.5 & 0.2 & 0.3 \\ 0.0 & 0.0 & 0.0 & 0.6 & 0.4 \\ 0.0 & 0.0 & 0.0 & 0.2 & 0.8 \end{pmatrix}$<br>i. Construct the digraph.<br>ii. Compute mean time spent in transient states N.<br>iii. Calculate mean absorption time μ. | *CO3* | *PO2* | **10** |
| | | | **OR** | | | |
| | 4 | a) | Consider a Hidden Markov Model with three hidden states {A, B, C} and two observable states {X, Y}. Given the following transition(P) and emission probabilities(Q):<br>$P = \begin{pmatrix} 0.6 & 0.2 & 0.2 \\ 0.6 & 0.3 & 0.1 \\ 0.4 & 0.3 & 0.4 \end{pmatrix} Q = \begin{pmatrix} 0.6 & 0.4 \\ 0.8 & 0.2 \\ 0.3 & 0.7 \end{pmatrix}$<br>The initial distribution is given by (0.5, 0.2,0.3).<br>Analyze the hidden states corresponding to the observed sequence {X, Y}. | *CO3* | *PO4* | **10** |
| | | b) | Consider a Markov Chain with transition probability matrix<br>$P = \begin{bmatrix} 0.0 & 0.0 & 0.5 & 0.0 & 0.5 \\ 0.0 & 0.5 & 0.0 & 0.5 & 0.0 \\ 0.5 & 0.0 & 0.0 & 0.0 & 0.5 \\ 0.0 & 0.5 & 0.0 & 0.5 & 0.0 \\ 0.5 & 0.0 & 0.5 & 0.0 & 0.0 \end{bmatrix}$<br>i. Give the digraph for the given transition probability matrix<br>ii. Verify whether the Markov chain is reducible or irreducible | *CO2* | *PO3* | **4** |
| | | c) | Describe the Markov decision process with recycling robot example | *CO2* | *PO2* | **6** |

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| | | | **UNIT - IV** | | | |
| | 5 | a) | Illustrate reinforcement learning with an example | *CO1* | *PO2* | **4** |
| | | b) | Write the Q-learning algorithm and also define the terms :<br>i. Policy<br>ii. Returns | *CO1* | *PO2* | **6** |
| | | c) | Consider a grid-world environment represented as a 2x3 grid. Six grid squares represents states. Agent can move from one state to another in the directions left, right, top and down. The top right grid cell represent goal state G(Goal state is an absorbing state). The agent starts at the bottom-left corner. The agent receives a reward of +100 for reaching the goal state and 0 for all other transitions. Given discount factor=0.9. Now,<br>i. Construct the Q-table.<br>ii. Identify the optimal policy, corresponding to actions with maximal Q Values. | *CO3* | *PO4* | **10** |
| | | | **OR** | | | |
| | 6 | a) | Differentiate between the following:<br>i. Exploration and Exploitation<br>ii. On-policy and off-policy methods | *CO2* | *PO1* | **6** |
| | | b) | Explain the temporal difference learning and also provide its algorithm | *CO1* | *PO1* | **6** |
| | | c) | Illustrate the following with suitable equations:<br>i. Q function<br>ii. Monte-Carlo reinforcement learning<br>iii. State Action Reward State Action (SARSA)<br>iv. Value function | *CO1* | *PO2* | **8** |
| | | | **UNIT - V** | | | |
| | 7 | a) | Explain the Actor-Critic architecture in brief and also provide the algorithm | *CO1* | *PO1* | **10** |
| | | b) | Analyze how are policy gradient method differ from value based method. | *CO2* | *PO2* | **5** |
| | | c) | Describe any two real world applications based on actor-critic methods | *CO1* | *PO1* | **5** |

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