



INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)
Dundigal, Hyderabad-500043

COMPUTER SCIENCE AND ENGINEERING

TUTORIAL QUESTION BANK

Course Title	MATHEMATICAL FOUNDATION OF COMPUTER SCIENCE				
Course Code	BCSB01				
Programme	M.Tech				
Semester	I	CSE			
Course Type	Core				
Regulation	IARE - R18				
Course Structure	Theory			Practical	
	Lectures	Tutorials	Credits	Laboratory	Credits
	3	-	3	-	-
Chief Coordinator	Ms. G. Sulakshana, Assistant Professor, CSE				
Course Faculty	Ms. G. Sulakshana, Assistant Professor, CSE				

COURSE OBJECTIVES:

The course should enable the students to:	
I	Understand the mathematical fundamentals that is prerequisites for a variety of courses like Data mining, Network protocols, analysis of Web traffic, Computer security, Software engineering, Computer architecture, operating systems, distributed systems, Bioinformatics, Machine learning.
II	Understand and apply the mathematical logics to many modern techniques in information technology like machine learning, programming language design, and concurrency.
III	Studying of various sampling and classification problems.

COURSE OUTCOMES (COs):

CO 1	Describe various concepts of probability theory and Distributions.
CO 2	Demonstrate sampling distributions of estimators and methods of moments.
CO 3	Explore statistical inference techniques and apply regression, PCA etc. for classification problems.
CO 4	Enrich the knowledge on applications of graph theory and combinatorial problem
CO 5	Identify the applications of mathematical and statistical techniques to emerging areas of Information Technology.

COURSE LEARNING OUTCOMES (CLOs):

BCSB01.01	Understand basic concepts probability theory, mass, density etc.
BCSB01.02	Analyze various Distribution Functions and apply to real world problems.
BCSB01.03	Identify importance of the Central Limit Theorem, Markov chains
BCSB01.04	Apply random sampling theory and distribution of estimators to various computer science applications
BCSB01.05	Describe Methods of Moments and Maximum Likelihood to solve problems
BCSB01.06	Construct and evaluate Regression models for classification problems
BCSB01.07	Analyze importance of Principal component analysis in developing predictive models and exploratory data analysis.
BCSB01.08	Understand problem of over fitting model and choose correct model.
BCSB01.09	Analyze Euler's and Hamilton rule for a simple connected graph in NP-complete problems
BCSB01.10	Solve discrete probability and set problems using permutations and combination
BCSB01.11	Identify the solution for various combinatorial enumeration problems
BCSB01.12	Apply various graph theory concepts in Network protocol design, web traffic analysis and distributed systems
BCSB01.13	Understand the basic concepts of Software Engineering, Computer Architecture
BCSB01.14	Analyze applications of Statistics in Data mining , machine learning and Bioinformatics
BCSB01.15	Understand operating system and distributed system concepts principles

TUTORIAL QUESTION BANK

UNIT-I				
INTRODUCTION				
Part - A (Short Answer Questions)				
S No	QUESTIONS	Blooms Taxonomy Level	Course Outcomes	Course Learning Outcomes (CLOs)
1	Define Probability mass function?	Remember	CO 1	BCSB01.03
2	Describe density, and cumulative distribution functions?	Remember	CO 1	BCSB01.02
3	Discuss Parametric families of distributions?	Remember	CO 1	BCSB01.02
4	Define Expected value?	Understand	CO 1	BCSB01.02
5	Describe variance, conditional expectation?	Understand	CO 1	BCSB01.02
6	Describe univariate ?	Remember	CO 1	BCSB01.02
7	Describe multivariate?	Remember	CO 1	BCSB01.02
8	Discuss Probabilistic inequalities?	Remember	CO 1	BCSB01.04
9	Define Markov chains?	Remember	CO 1	BCSB01.02
10	Define cumulative distribution functions?	Remember	CO 1	BCSB01.01
Part - B (Long Answer Questions)				
1	Describe variance and properties of variance?	Remember	CO 1	BCSB01.02
2	Write about Probability mass function?	Understand	CO 1	BCSB01.02
3	Write about cumulative distribution functions?	Understand	CO 1	BCSB01.02
4	Write in detail about Parametric families of distributions?	Understand	CO 1	BCSB01.01
5	Discuss the applications of the univariate and multivariate Central Limit Theorem?	Remember	CO 1	BCSB01.01
6.	Describe Probabilistic inequalities and Explain in detail about gamma Inequality?	Remember	CO 1	BCSB01.01
7.	Illustrate the parametric families of distributions and discuss Location-Scale Families briefly?	Remember	CO 1	BCSB01.02
8	Explain the applications of the univariate and multivariate Central Limit Theorem?	Remember	CO 1	BCSB01.01
9.	List the Probabilistic inequalities and Explain in detail about The Gaussian Tail Inequality?	Remember	CO 1	BCSB01.01
10	Discuss various Markov chains with the examples?	Understand	CO 1	BCSB01.01
Part – C (Problem Solving And Critical Thinking Questions)				
1	One percent of jobs arriving at a computer system need to wait until weekends for scheduling. Owing to core – size limitations. Find the probability that among a sample of 200 jobs there are no jobs that have to wait until the weekend for scheduling. { You may use poisson approximation o the binomial distributions)	Apply	CO 1	BCSB01.01
2	A A Mischievous student wants to break into a computer file, which is password protected. Assume that there are n equality likely passwords, and that the sudden chooses passwords independently and at random and ties them. Let N_n be the number of trails required to break into the file. Determine the pmf of N_n (a) If unsuccessful passwords are not eliminated from further selections, and (b) If they are.	Apply	CO 1	BCSB01.02
3	Construct an example of a discrete random variable X that takes on each of the values $-b, 0, b$ with non zero probability, so that Chebycheve inequality becomes an equality when applied to the expression: $P(X - E[X] \geq b) = b^{-2}$. In particular determine $p_X(-b)$, $p_X(0)$ and $p_X(b)$.	Analyze	CO 1	BCSB01.01

4	We are given an un ordered list with n distinct keys. We are searching linearly for a specific key that has a probability p of being present in the list (and probability q of being absent). Given that the key is in the list, the Probability of its being in position I is 1/n, i = 1, 2, 3, ...n. Compute the expected number of comparisons for : i) A successful search ii) An Unsuccessful search iii) A search (Unconditionally)	Analyze	CO 1	BCSB01.01
5	Assume that a computer system is one of three states: Busy, Idle or undergoin repair, repectively denoted by states 0,1 and 2. Observing its state at 2 P.M. each day, we believe that the system approximately behaves like a homogeneous Markove chain with transition probability matrix : P = $\begin{matrix} & 0 & 1 & 2 \\ \begin{matrix} 0 \\ 1 \\ 2 \end{matrix} & \begin{matrix} 0.6 & 0.2 & 0.2 \\ 0.2 & 0.8 & 0.1 \\ 0.6 & 0.0 & 0.4 \end{matrix} \end{matrix}$ Prove that the chain is irreducible, and determine the steady – state probabilities.	Apply	CO 1	BCSB01.01

UNIT- II

RANDOM SAMPLES

Part - A (Short Answer Questions)

1	Define random sample?	Remember	CO 2	BCSB01.05
2	Define methods of moments?	Remember	CO 2	BCSB01.05
3	Define Maximum Likelihood?	Remember	CO 2	BCSB01.06
4	Discuss advantages of Methods of Moments?	Remember	CO 2	BCSB01.05
5	Discuss disadvantages of Methods of Moments?	Understand	CO 2	BCSB01.05
6	Discuss advantages of Maximum Likelihood?	Remember	CO 2	BCSB01.05
7	Discuss disadvantages of Maximum Likelihood?	Understand	CO 2	BCSB01.05
8	Define sampling distributions?	Understand	CO 2	BCSB01.05
9	Define sampling distributions of sample size?	Remember	CO 2	BCSB01.05
10	Define sampling distributions of precision?	Understand	CO 2	BCSB01.08

Part-B (Long Answer Questions)

1	Discuss sampling distributions of estimators? Explain sampling distributions of sample size and precision?	Remember	CO 2	BCSB01.05
2	What is Methods of Moments and Maximum Likelihood and discuss its advantages and disadvantages?	Understand	CO 2	BCSB01.08
3	Discuss simple random sampling and its techniques with an examples?	Understand	CO 2	BCSB01.05
4	What is Random samples and list the types and methods of random sampling ?	Understand	CO 2	BCSB01.05
5	Explain the methods of random sampling?	Remember	CO 2	BCSB01.05
6	Explain the types of random sampling?	Understand	CO 2	BCSB01.05
7	Explain Sampling from normal distribution with any two examples (one must be from computer Science application)	Understand	CO 2	BCSB01.08
8	Explain Sampling from Exponential distribution with any two examples (one must be from computer Science application)	Understand	CO 2	BCSB01.08
9	Explain Sampling from Bernoulli distribution with any two examples (one must be from computer Science application)	Understand	CO 2	BCSB01.05
10	Explain Sampling from poisson distribution with any two examples (one must be from computer Science application)	Understand	CO 2	BCSB01.05

Part – C (Problem Solving And Critical Thinking Questions)

1.	Show that the method –of-moments estimators of the population variance are given by the sample mean \bar{X} and $(n -1)S^2 / n$, respectively. Show that the method of Moments estimator of the population variance is Biased.	Apply	CO 2	BCSB01.05
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2.	Suppose that the CPU service time X of a job is gamma distributed with parameters λ and α . Based on a random sample of n observed service times, x_1, x_2, \dots, x_n , we wish to estimate parameters λ and α . Show that maximum likelihood estimators of λ and α do not yield a closed-form solution.	Apply	CO 2	BCSB01.05
3.	Derive method of moments estimates for the parameters λ_1 and λ_2 of two – stage hypo exponential distribution.	Apply	CO 2	BCSB01.08
4.	In an exhaustive, non replacement life test of ten components, the observed times to failure (in hours) are: 1200, 1500, 1625, 1725, 1750, 1785, 1800, 1965, 1900 and 1950. Assuming that component lifetimes are normally distributed, compute an estimate of the mean life μ and variance σ^2 . Also compute a 90 percent confidence interval for the mean life.	Apply	CO 2	BCSB01.08
5.	Fifteen Ram chips are put into operation, and a trusted nonreplacement life test is conducted until three chips have failed. Corresponding failure times are noted as $t_1 = 850$ hours, $t_2 = 900$ hour, $t_3 = 1000$ hours. Assume that the devices follow an exponential failure law. a) Obtain a point estimate of the mean life. b) Obtain 90 percent confidence interval for the mean life of a chip.	Apply	CO 2	BCSB01.05

UNIT III

STATISTICAL INTERFACE

Part - A(Short Answer Questions)

1	Define Statistical inference?	Understand	CO 3	BCSB01.09
2	Differentiate least squares Regression curve?	Understand	CO 3	BCSB01.11
3	Define Coefficient of Determination ?	Understand	CO 3	BCSB01.10
4	Differentiate linear regression from non linear regression?	Understand	CO 3	BCSB01.10
5	Give an example for Scatter Diagram.	Understand	CO 3	BCSB01.10
6	Define Regression Coefficient?	Understand	CO 3	BCSB01.10
7	What is the purpose of Principal Component Analysis.	Understand	CO 3	BCSB01.10
8	List various approaches to prevent over fitting models ?	Understand	CO 3	BCSB01.10
9	Describe Eigen vector and Eigen values with examples?	Understand	CO 3	BCSB01.09
10	Describe model assessment?	Understand	CO 3	BCSB01.10

Part–B (Long Answer Questions)

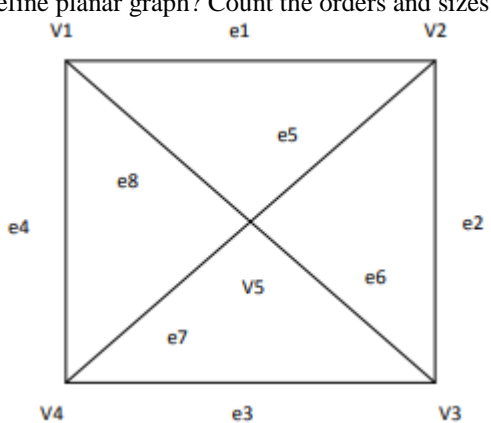
1	Discuss multivariate statistical models with one application from computer science.	Understand	CO 3	BCSB01.09
2	Explain the problem of over fitting model assessment?	Understand	CO 3	BCSB01.09
3	Explain Role of confidence intervals in Linear regression.	Understand	CO 3	BCSB01.11
4	What is Statistical inference? Explain various modes of inference for making info informed choices in analyzing data?	Remember	CO 3	BCSB01.10
5	Derive Coefficient of determination.	Understand	CO 3	BCSB01.10

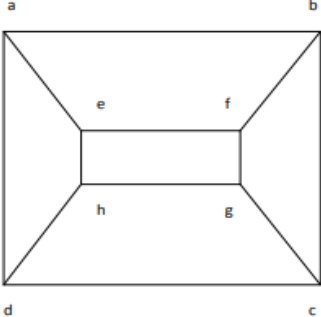
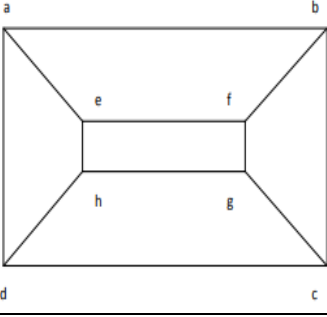
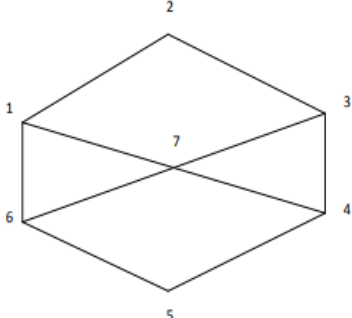
6	Explain over fitting model in regression analysis through graphical illustration. What are the problems associated with such models?	Understand	CO 3	BCSB01.10
7	Discuss how to interpret various regression results and also how to use them in prediction process.	Remember	CO 3	BCSB01.10
8	What do the eigenvectors of the covariance matrix give us? At what point in the PCA process can we decide to compress the data? What effect does this have?	Understand	CO 3	BCSB01.11
9	Explain steps to be performed to analyze on given data through principle component Analysis.	Understand	CO 3	BCSB01.10
10	Describe how regression models can be used in solving classification problems.	Remember	CO 3	BCSB01.10

Part – C (Problem Solving And Critical Thinking Questions)																						
1	<p>Compute coefficient of determination for the data</p> <table border="1" style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th>modules</th> <th>Avg detection latency Time1</th> <th>Avg detection latency Time2</th> </tr> </thead> <tbody> <tr> <td>3</td> <td>1.45</td> <td>1.5</td> </tr> <tr> <td>5</td> <td>1.30</td> <td>1.26</td> </tr> <tr> <td>7</td> <td>1.20</td> <td>1.23</td> </tr> <tr> <td>11</td> <td>1.10</td> <td>1.08</td> </tr> <tr> <td>13</td> <td>1.05</td> <td>1.03</td> </tr> </tbody> </table>	modules	Avg detection latency Time1	Avg detection latency Time2	3	1.45	1.5	5	1.30	1.26	7	1.20	1.23	11	1.10	1.08	13	1.05	1.03	Apply	CO 3	BCSB01.09
modules	Avg detection latency Time1	Avg detection latency Time2																				
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13	1.05	1.03																				
2	Prove \hat{A} is an unbiased estimator of a ; $E[\hat{A}] = a$	Apply	CO 3	BCSB01.09																		
3	Derive normal equations of least squares and show that these are special case of regression. Determine the regression equation by using the regression slope coefficient and intercept value as shown in the regression table given below:	Analyze	CO 3	BCSB01.11																		
4	Determine the regression equation by using the regression slope coefficient and intercept value as shown in the regression table given below: X 55 60 65 70 80 Y 52 54 56 58 62	Apply	CO 3	BCSB01.10																		
5	Analyze the following 3-variate data set with 10 observations through PCA. Each observation consists of 3 measurements on a wafer: thickness, horizontal displacement, and vertical displacement. 7 4 6 8 8 7 5 9 7 8 X = 4 1 3 6 5 2 3 5 4 2 3 8 5 1 7 9 3 8 5 2	Apply	CO 3	BCSB01.10																		

UNIT IV

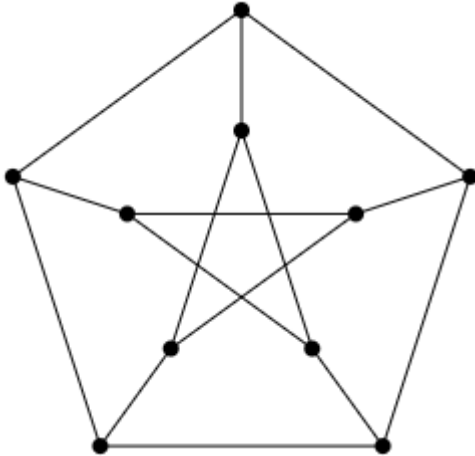
GRAPH THEORY

Part – A (Short Answer Questions)				
1	Define Graph Isomorphism.	Understand	CO 4	BCSB01.14
2	<p>Define planar graph? Count the orders and sizes of given graph?</p> 	Understand	CO 4	BCSB01.14
3	Identify the number of ways we can select the counting rules from the class Which having 6 boys and 5 girls	Understand	CO 4	BCSB01.14
4	Enumerate the number of ways forming a 4 letter word from the word MIXTURE in which at least one letter is repeated?	Understand	CO 4	BCSB01.14
5	Describe, that in how many numbers can be formed using the digits 1, 3, 4,5,6,8 and 9 if no repetitions are allowed?	Remember	CO 4	BCSB01.14

6	<p>Construct Hamiltonian graph for the given below graph?</p> 	Understand	CO 4	BCSB01.14
7	<p>Assign the proper coloring for the below given graph?</p> 	Understand	CO 4	BCSB01.14
8	<p>Identify chromatic number of given graph?</p> 	Understand	CO 4	BCSB01.14
9	<p>Express how many ways are there to seat 10 boys and 10 girls around a circular table, if boys and girls seat alternatively?</p>	Understand	CO 4	BCSB01.15
10	<p>Define sum rule and product rule?</p>	Understand	CO 4	BCSB01.15
Part – B (Long Answer Questions)				
1	<p>Enumerate Hamiltonian graph? Define proper coloring and chromatic number of a graph?</p>	Understand	CO 4	BCSB01.15
2	<p>Suppose a connected graph G.G has degree sequence d_1, d_2, \dots, d_n. How many edges must be added to GG so that the resulting graph has an Euler circuit? Explain.</p>	Remember	CO 4	BCSB01.14
3	<p>Prove that A connected graph GG has an Euler walk if and only if exactly two vertices have odd degree.</p>	Understand	CO 4	BCSB01.14
4	<p>Prove that Every bipartite graph has chromatic number two.</p>	Understand	CO 4	BCSB01.14
5	<p>Prove that The chromatic number of a planar graph is at most four.</p>	Understand	CO 4	BCSB01.14
6	<p>Describe, in how many ways we can distribute 12 identical pencils to 4 children such that every children get at least one pencil?</p>	Understand	CO 4	BCSB01.14
7	<p>Solve the words. (a) TALLAHASSEE (b) MISSISSIPPI How many arrangements can be made such that, (a) No two letters A of TALLAHASSEE appear together</p>	Remember	CO 4	BCSB01.15

	(b) Number of 4 letter words for both the given words.			
8	Select the number of rows of 6 Americans, 7 Mexicans and 10 Canadians in which an American invariably stands between a Mexican and a Canadian never stand side by side.	Understand	CO 4	BCSB01.14
9	Select in how many integers between 10^5 and 10^6 (i) Have no digit other than 2,5 or 8 (ii) Have no digit other than 0,2,5 or 8	Understand	CO 4	BCSB01.14
10	Estimate in how many arrangements are there for the word `MISSISSIPPI` with no two pair of consecutive same letters?	Remember	CO 4	BCSB01.14

Part – C (Problem Solving And Critical Thinking Questions)

1	The graph shown below is the Petersen graph. Does it have a Hamilton cycle? Justify your answer. Does it have a Hamilton path? Justify your answer.	Apply	CO 4	BCSB01.09
				
2	A graph is Eulerian if and only if it is a connected graph in which every vertex has even degree.			
3	Solve the following time table problem using graph coloring concept. Design a simple class schedule with no conflict between a set of teachers and a set of courses with the following set of constraints: 1. No same courses can be taken by any teacher or batch for a given time slot. 2. Minimize the number of time slots required and prove that it is optimum.			
4	A square board with side-length of 8 cm is divided into 64 squares with side-length of 1 cm each. Each square can be painted black or white. Find the total number of ways to color the board so that every square with side-length of 2 cm formed with 4 small squares with a common vertex has two black squares and two white squares.			
5	A spider has 8 feet, 8 different shoes and 8 different socks. Find the number of ways in which the spider can put on the 8 socks and the 8 shoes (considering the order in which it puts them on). The only rule is that to put a shoe on the spider must already have a sock on that foot.			

UNIT V

COMPUTER SCIENCE AND ENGINEERING APPLICATIONS

Part - A (Short Answer Questions)

1	Distinguish Data mining from KDD	Understand	CO 5	BCSB01.09
2	Explain various functionalities of Data Mining	Understand	CO 5	BCSB01.11
3	What is web traffic? How to monitor Web traffic?	Remember	CO 5	BCSB01.10
4	What are objectives of Computer security?	Understand	CO 5	BCSB01.10
5	Discuss the importance of software requirement specification(SRS).	Understand	CO 5	BCSB01.10
6	Write the differences between Multi tasking and multi programming.	Remember	CO 5	BCSB01.10
7	List various diagrams in modeling object oriented system.	Understand	CO 5	BCSB01.10

8	Define distributed system. Give any three examples for DS	Understand	CO 5	BCSB01.10
9	Define Bio informatics.	Understand	CO 5	BCSB01.09
10	Explain how artificial neuron 'Perception' resembles human Neuron.	Remember	CO 5	BCSB01.10
Part - B (Long Answer Questions)				
1	Explain in detail which mathematical concepts are applied in each of the following data mining functionalities a. Any two clustering algorithms b. Any two classification algorithms c. Any two association rule mining algorithms	Understand	CO 5	BCSB01.15
2	Compare and contrast seven layered architecture and TCP/IP architecture	Understand	CO 5	BCSB01.14
3	Discuss various types of computer security threats and how to avoid them.	Understand	CO 5	BCSB01.14
4	Explain various steps of any two process development models used in developing projects.	Understand	CO 5	BCSB01.14
5	Describe Various services of operating system.	Remember	CO 5	BCSB01.14
6	Write about various types of operating systems.	Understand	CO 5	BCSB01.14
7	Discuss various issues in designing distributed systems.	Understand	CO 5	BCSB01.15
8	Explain database search tools BLAST and FASTA in Bio Informatics	Understand	CO 5	BCSB01.14
9	Explain Supervised, Unsupervised, Semi supervised and Reinforcement learning techniques with examples.	Remember	CO 5	BCSB01.14
10	Explain Regression approach to classification problems with examples.	Understand	CO 5	BCSB01.14
Part – C (Problem Solving And Critical Thinking Questions)				
1	Discuss the role of Science and Mathematics in Software Development.	Understand	CO 5	BCSB01.15
2	Compare various functionalities of Windows and Linux operating systems	Understand	CO 5	BCSB01.14
3	Compare Various tools/Diagrams/ Techniques used in developing system using Process orientation and Object orientation.	Understand	CO 5	BCSB01.14
4	Give two reasons/examples of why default configurations for software/hardware can be a security problem.	Remember	CO 5	BCSB01.14

Prepared by:

G. Sulakshana, Assistant Professor, CSE

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