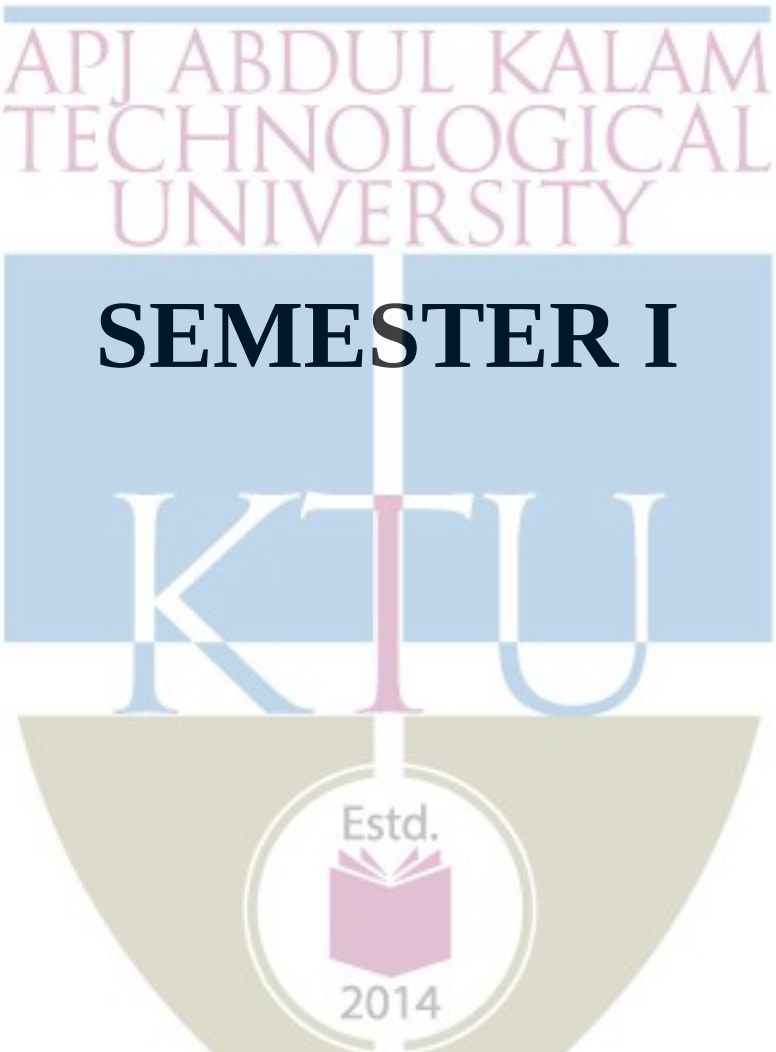


SEMESTER I

Discipline: Computer Science and Engineering

Stream: CS1 (Computer Science and Engineering, Computer Science and Systems Engineering, Computer Science and Information System, Computer and Information Science)

221TCS100	ADVANCED MACHINE LEARNING	CATEGORY	L	T	P	CREDIT
		DISCIPLINE CORE 1	3	0	0	3

Preamble: This course introduces machine learning concepts and popular machine learning algorithms. It will cover the standard and most popular supervised learning algorithms including linear regression, logistic regression, decision trees, k-nearest neighbour, an introduction to Bayesian learning and the naive Bayes algorithm, support vector machines and kernels and basic clustering algorithms. Dimensionality reduction methods and some applications to real world problems will also be discussed. It helps the learners to develop application machine learning based solutions for real world applications.

Course Outcomes:

After the completion of the course the student will be able to: *

CO 1	Analyse the Machine Learning concepts, classifications of Machine Learning algorithms and basic parameter estimation methods. **(Cognitive Knowledge Level: Analyse)**
CO 2	Illustrate the concepts of regression and classification techniques **(Cognitive Knowledge Level: Apply)**
CO 3	Describe unsupervised learning concepts and dimensionality reduction techniques. (**Cognitive Knowledge Level: Apply**)
CO 4	Explain Support Vector Machine concepts and graphical models. **(Cognitive Knowledge Level: Apply)**
CO 5	Choose suitable model parameters for different machine learning techniques and to evaluate a model performance. **(Cognitive Knowledge Level: Apply)**
CO6	Design, implement and analyse machine learning solution for a real-world problem. **(Cognitive Knowledge Level: Create)**

Program Outcomes (PO)

Outcomes are the attributes that are to be demonstrated by a graduate after completing the course.

PO1: An ability to independently carry out research/investigation and development work in engineering and allied streams

PO2: An ability to communicate effectively, write and present technical reports on complex engineering activities by interacting with the engineering fraternity and with society at large.

PO3: An ability to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program

PO4: An ability to apply stream knowledge to design or develop solutions for real world problems by following the standards

PO5: An ability to identify, select and apply appropriate techniques, resources and state-of-the-art tool to model, analyse and solve practical engineering problems.

PO6: An ability to engage in life-long learning for the design and development related to the stream related problems taking into consideration sustainability, societal, ethical and environmental aspects

PO7: An ability to develop cognitive load management skills related to project management and finance which focus on Entrepreneurship and Industry relevance.

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
CO 1	✓		✓		✓	✓	
CO 2	✓		✓	✓	✓	✓	
CO 3	✓		✓	✓	✓	✓	
CO 4	✓		✓	✓	✓	✓	
CO 5	✓		✓	✓	✓	✓	
CO 6	✓	✓	✓	✓	✓	✓	✓

Assessment Pattern

Bloom's Category	**End Semester Examination**
Apply	60-80%
Analyse	20-40%
Evaluate	
Create	

Mark distribution

Total Marks	**CIE**	**ESE**	**ESE Duration**
100	40	60	2.5 hours

Continuous Internal Evaluation Pattern:

Evaluation shall only be based on application, analysis or design-based questions (for both internal and end semester examinations).

Continuous Internal Evaluation : 40 marks

Micro project/Course based project : 20 marks

Course based task/Seminar/Quiz : 10 marks

Test paper, 1 no. : 10 marks

The project shall be done individually. Group projects not permitted.

Test paper shall include minimum 80% of the syllabus.

Course based task/test paper questions shall be useful in the testing of knowledge, skills, comprehension, application, analysis, synthesis, evaluation and understanding of the students.

End Semester Examination Pattern:

The end semester examination will be conducted by the University. There will be two parts; Part A and Part B. Part A contain 5 numerical questions with 1 question from each module, having 5 marks for each question. (Such questions shall be useful in the testing of knowledge, skills, comprehension, application, analysis, synthesis, evaluation and understanding of the students). Students shall answer all questions.

Part B will contain 7 questions (such questions shall be useful in the testing of overall achievement and maturity of the students in a course, through long answer questions relating to theoretical/practical knowledge, derivations, problem solving and quantitative evaluation), with minimum one question from each module of which student should answer any five. Each question can carry 7 marks.

Total duration of the examination will be 150 minutes.

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Suppose that X is a discrete random variable with the following probability mass function: where $0 \leq \theta \leq 1$ is a parameter. The following 10 independent observations were taken from such a distribution: $(3, 0, 2, 1, 3, 2, 1, 0, 2, 1)$. What is the maximum likelihood estimate of θ.

X	0	1	2	3
$P(X)$	$2\theta/3$	$\theta/3$	$2(1-\theta)/3$	$(1-\theta)/3$

2. What is the difference between Maximum Likelihood estimation (MLE) and Maximum a Posteriori (MAP) estimation?

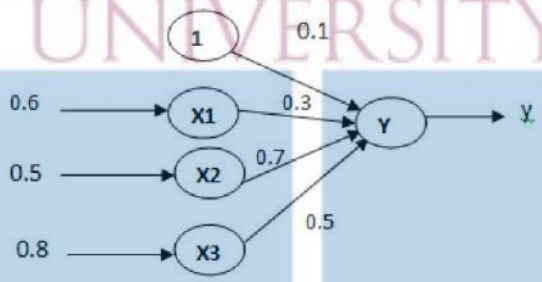
3. A gamma distribution with parameters α, β has the following density function, where $\Gamma(t)$ is the gamma function.

$$p(x) = \frac{\beta^\alpha}{\Gamma(\alpha)} x^{\alpha-1} e^{-\beta x}$$

If the posterior distribution is in the same family as the prior distribution, then we say that the prior distribution is the conjugate prior for the likelihood function. Using the Gamma distribution as a prior, show that the Exponential distribution is a conjugate prior of the Gamma distribution. Also, find the maximum a posteriori estimator for the parameter of the Exponential distribution as a function of $\boldsymbol{\alpha}$ and $\boldsymbol{\beta}$.

Course Outcome 2 (CO2)

1. How can we interpret the output of a two-class logistic regression classifier as a robability?
2. Calculate the output of the following neuron Y if the activation function is a binary sigmoid.



3. Suppose you have a 3-dimensional input x = (x1, x2, x3) = (2, 2, 1) fully connected with weights (0.5, 0.3, 0.2) to one neuron which is in the hidden layer with sigmoid activation function. Calculate the output of the hidden layer neuron.
4. Consider the case of the XOR function in which the two points {(0, 0),(1, 1)} belong to one class, and the other two points {(1, 0),(0, 1)} belong to the other class. Design a multilayer perceptron for this binary classification problem.
5. Why does a single perceptron cannot simulate simple XOR function? Explain how this limitation is overcome?
6. Consider a naive Bayes classifier with 3 boolean input variables, **X1**, **X2** and **X3**, and one boolean output, **Y**. How many parameters must be estimated to train such a naive Bayes classifier? How many parameters would have to be estimated to learn the above classifier if we do not make the naive Bayes conditional independence assumption?

Course Outcome 3(CO3):

1. Describe the basic operation of k-means clustering.
2. A Poisson distribution is used to model data that consists of non-negative integers. Suppose you observe m integers in your training set. Your model assumption is that each integer is sampled from one of two different Gaussian distributions. You would like to learn this model using the EM algorithm. List all the parameters of the model. Derive the E-step and M-step for this model.

3. A uni-variate Gaussian distribution is used to model data that consists of non-negative integers. Suppose you observe m integers in your training set. Your model assumption is that each integer is sampled from one of two different Gaussian distributions. You would like to learn this model using the EM algorithm. List all the parameters of the model. Derive the E-step and M-step for the model.

4. Suppose you want to cluster the eight points shown below using **k**-means

	A_1	A_2
x_1	2	10
x_2	2	5
x_3	8	4
x_4	5	8
x_5	7	5
x_6	6	4
x_7	1	2
x_8	4	9

Assume that **k = 3** and that initially the points are assigned to clusters as follows:

C1 = {x1, x2, x3}, C2 = {x4, x5, x6}, C3 = {x7, x8}. Apply the **k**-means algorithm until convergence, using the Manhattan distance.

Course Outcome 4 (CO4):

1. Describe how Support Vector Machines can be extended to make use of kernels. Illustrate with reference to the Gaussian kernel $K(x, y) = e^{-y}$, where $y = (x-y)^2$.

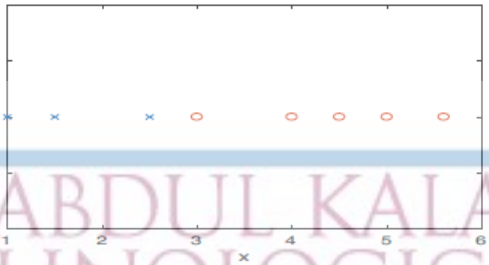
2. Suppose that you have a linear support vector machine(SVM) binary classifier. Consider a point that is currently classified correctly, and is far away from the decision boundary. If you remove the point from the training set, and re-train the classifier, will the decision boundary change or stay the same? Justify your answer.

3. What is the primary motivation for using the kernel trick in machine learning algorithms?

4. Show that the Boolean function $(x_1 \wedge x_2) \vee (\neg x_1 \wedge \neg x_2)$ is not linearly separable (i.e. there is no linear classifier $sign(w_1 x_1 + w_2 x_2 + b)$ that classifies all 4 possible input points correctly). Assume that "true" is represented by 1 and "false" is represented by −1. Show that there is a linear separator for this Boolean function when we use the kernel $K(x, y) = (x \cdot y)^2$ (***x.y*** denotes the ordinary inner product) . Give the weights and the value of ***b*** for one such separator.

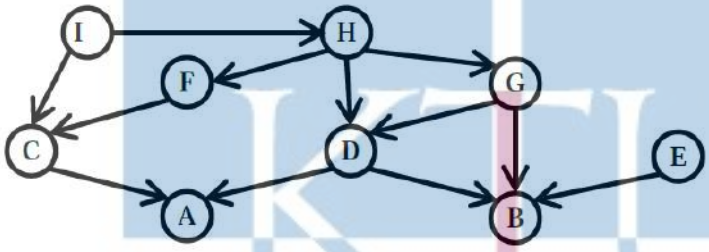
5. Consider the following one-dimensional training data set, 'x' denotes negative examples and 'o' positive examples. The exact data points and their labels are given in the table.

Suppose a SVM is used to classify this data. Indicate which are the support vectors and mark the decision boundary. Give the value of the cost function and of the model parameters after training.



x	1	1.5	2.5	3	4	4.5	5	5.6
y	-1	-1	-1	1	1	1	1	1

6. Write down the factored conditional probability expression that corresponds to the graphical Bayesian Network shown below.



7. How do we learn the conditional probability tables (CPT) in Bayesian networks if information about some variables is missing? How are these variables called?

Course Outcome 5 (CO5):

1. Suppose 10000 patients get tested for flu; out of them, 9000 are actually healthy and 1000 are actually sick. For the sick people, a test was positive for 620 and negative for 380. For healthy people, the same test was positive for 180 and negative for 8820. Construct a confusion matrix for the data and compute the accuracy, precision and recall for the data.

2. Given the following data, construct the ROC curve of the data. Compute the AUC.

Threshold	TP	TN	FP	FN
1	0	25	0	29
2	7	25	0	22
3	18	24	1	11

4	26	20	5	3
5	29	11	14	0
6	29	0	25	0
7	29	0	25	0

3. With an example classification problem, explain the following terms: a) Hyper parameters b) Training set c) Validation sets d) Bias e) Variance.

4. What is ensemble learning? Can ensemble learning using linear classifiers learn classification of linearly non-separable sets?

5. Describe boosting. What is the relation between boosting and ensemble learning?

6. Classifier A attains 100% accuracy on the training set and 70% accuracy on the test set. Classifier B attains 70% accuracy on the training set and 75% accuracy on the test set. Which one is a better classifier. Justify your answer.

7. What are ROC space and ROC curve in machine learning? In ROC space, which points correspond to perfect prediction, always positive prediction and always negative prediction? Why?

8. Suppose there are three classifiers A,B and C. The (FPR, TPR) measures of the three classifiers are as follows – A (0, 1), B (1, 1) , C (1,0.5). Which can be considered as a perfect classifier? Justify your answer.

9. What does it mean for a classifier to have a high precision but low recall?

Model Question Paper

QP CODE:

Reg No: _____

Name: _____ **PAGES: 4**

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

FIRST SEMESTER M. TECH DEGREE EXAMINATION, MONTH & YEAR

Course Code: 221TCS100

Course Name: ADVANCED MACHINE LEARNING

Max. Marks : 60 **Duration: 2.5 Hours**

PART A

Answer All Questions. Each Question Carries 5 Marks

1. Explain the principle of the gradient descent algorithm.
2. In a two-class logistic regression model, the weight vector **w = [4, 3, 2, 1, 0]**. We apply it to some object that we would like to classify; the vectorized feature representation of this object is **x = [−2, 0,−3, 0.5, 3]**. What is the probability, according to the model, that this instance belongs to the positive class?
3. Expectation maximization (EM) is designed to find a maximum likelihood setting of the parameters of model when some of the data is missing. Does the algorithm converge? If so, do you obtain a locally or globally optimal set of parameters?
4. What is the basic idea of a Support Vector Machine?
5. What is the trade-off between bias and variance? **(5x5=25)**

Part B

(Answer any five questions. Each question carries 7 marks)

6. Suppose $x_1, ..., x_n$ are independent and identically distributed(iid) samples from a distribution with density **(7)**

$$f_X(x \mid \theta) = \begin{cases} \dfrac{\theta x^{\theta-1}}{3^\theta}, & 0 \le x \le 3 \\ 0, & \text{otherwise} \end{cases}$$

Find the maximum likelihood estimate (MLE) for θ.

7. Derive the gradient descent training rule assuming for the target function $o_d = w_0 + w_1x_1 + ... + w_nx_n$. Define explicitly the squared cost/error function E, assuming that a set of training examples D is provided, where each training example $d \varepsilon D$ is associated with the target output t_d. **(7)**

8. Cluster the following eight points representing locations into three clusters: ***A1(2, 10), A2(2, 5), A3(8, 4), A4(5, 8), A5(7, 5), A6(6, 4), A7(1, 2), A8(4, 9)***. **(7)**

Initial cluster centers are: ***A1(2, 10), A4(5, 8)*** and ***A7(1, 2)***.

The distance function between two points ***a = (x1, y1)*** and ***b = (x2, y2)*** is defined as D***(a, b) = |x2 – x1| + |y2 – y1|***

Use **k**-Means Algorithm to find the three cluster centers after the second iteration.

9. Describe Principal Component Analysis. What criterion does the method minimize? What is the objective of the method? Give a way to compute the solution from a matrix ***X*** encoding the features. **(7)**

10. Consider a support vector machine whose input space is 2-D, and the inner products are computed by means of the kernel ***K(x, y) = (x.y + 1)^2-1*** (***x.y*** denotes the ordinary inner product). Show that the mapping to feature space that is implicitly defined by this kernel is the mapping to 5-D given by **(7)**

$$\mathbf{x} = \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} \rightarrow \phi(\mathbf{x}) = \begin{bmatrix} x_1^2 \\ x_2^2 \\ \sqrt{2}\, x_1 x_2 \\ \sqrt{2}\, x_1 \\ \sqrt{2}\, x_2 \end{bmatrix}.$$

11. How does random forest classifier work? Why is a random forest better than a decision tree? **(7)**

12. Consider a two-class classification problem of predicting whether a photograph contains a man or a woman. Suppose we have a test dataset of 10 records with expected outcomes and a set of predictions from our classification algorithm. Compute the confusion matrix, accuracy, precision, recall, sensitivity and specificity on the following data. **(7)**

Sl.No.	Actual	Predicted
1	man	woman
2	man	man
3	woman	woman
4	man	man
5	man	woman
6	woman	woman
7	woman	man
8	man	man
9	man	woman
10	woman	woman

Syllabus

Module-1 (Parameter Estimation and Regression) 8 hours

Overview of machine learning: supervised, semi-supervised, unsupervised learning, reinforcement learning. Basics of parameter estimation: Maximum Likelihood Estimation (MLE), Maximum a Posteriori Estimation (MAP). Gradient Descent Algorithm, Batch Gradient Descent, Stochastic Gradient Descent. Regression algorithms: least squares linear regression, normal equations and closed form solution, Polynomial regression.

Module-2 (Regularization techniques and Classification algorithms) 9 hours

Overfitting, Regularization techniques - LASSO and RIDGE. Classification algorithms: linear and non-linear algorithms, Perceptrons, Logistic regression, Naive Bayes, Decision trees. Neural networks : Concept of Artificial neuron, Feed-Forward Neural Network, Back propagation algorithm.

Module-3 (Unsupervised learning) 8 hours

Unsupervised learning: clustering, k-means, Hierarchical clustering, Principal component analysis, Density-based spatial clustering of applications with noise (DBSCAN). Gaussian mixture models: Expectation Maximization (EM) algorithm for Gaussian mixture model.

Module-4 (Support Vector Machine and Graphical Models) 7 hours

Support vector machines and kernels: Max margin classification, Nonlinear SVM and the kernel trick, nonlinear decision boundaries, Kernel functions. Basics of graphical models - Bayesian networks, Hidden Markov model - Inference and estimation.

Module-5 (Evaluation Metrics and Sampling Methods) 8 hours

Classification Performance Evaluation Metrics: Accuracy, Precision, Precision, Recall, Specificity, False Positive Rate (FPR), F1 Score, Receiver Operator Characteristic (ROC) Curve, AUC. Regression Performance Evaluation Metrics: Mean Absolute Error (MAE), Root Mean Squared Error (RMSE), R Squared/Coefficient of Determination. Clustering Performance Evaluation Metrics: Purity, Jaccard index, Normalized Mutual Information, Clustering Accuracy, Silhouette Coefficient, Dunn's Index. Boosting: AdaBoost, gradient boosting machines. Resampling methods: cross-validation, bootstrap. Ensemble methods: bagging, boosting, random forests Practical aspects in machine learning: data preprocessing, overfitting, accuracy estimation, parameter and model selection Bias-Variance tradeoff

Course Plan

No	Topics	No. of Lectures (40)
1	**Module-1 (Parameter Estimation and Regression) 8 hours**	
1.1	Overview of machine learning: supervised, semi-supervised, unsupervised learning, reinforcement learning.	1
1.2	Basics of parameter estimation: Maximum Likelihood Estimation (MLE)	1
1.3	Basics of parameter estimation: Maximum Likelihood Estimation (MLE) - Examples	1
1.4	Basics of parameter estimation: Maximum a Posteriori Estimation (MAP)	1
1.5	Basics of parameter estimation: Maximum a Posteriori Estimation (MAP) - Example	1
1.6	Gradient Descent Algorithm, Batch Gradient Descent, Stochastic Gradient Descent	1
1.7	Regression algorithms: least squares linear regression, normal equations and closed form solution	1
1.8	Polynomial regression	1
2	**Module-2 (Regularization techniques and Classification algorithms) 9 hours**	

2.1	Overfitting, Regularization techniques - LASSO and RIDGE	
2.2	Classification algorithms: linear and non-linear algorithms	
2.3	Perceptrons	
2.4	Logistic regression	
2.5	Naive Bayes	
2.6	Decision trees	
2.7	Neural networks: Concept of Artificial neuron	
2.8	Feed-Forward Neural Network	
2.9	Back propagation algorithm	
3	**Module-3 (Unsupervised learning) 8 hours**	
3.1	Unsupervised learning: clustering, k-means	
3.2	Hierarchical clustering	
3.3	Principal component analysis	
3.4	Density-based spatial clustering of applications with noise (DBSCAN)	
3.5	Gaussian mixture models: Expectation Maximization (EM) algorithm for Gaussian mixture model	
3.6	Gaussian mixture models: Expectation Maximization (EM) algorithm for Gaussian mixture model	
4	**Module-4 (Support Vector Machine and Graphical Models) 7 hours**	
4.1	Support vector machines and kernels: Max margin classification	
4.2	Support vector machines: Max margin classification	
4.3	Nonlinear SVM and the kernel trick, nonlinear decision boundaries	
4.3	Kernel functions	
4.5	Basics of graphical models - Bayesian networks	
4.6	Hidden Markov model - Inference and estimation	
4.7	Hidden Markov model - Inference and estimation	
4.8	Hidden Markov model - Inference and estimation	
5	**Module-5 (Evaluation Metrics and Sampling Methods) 8 hours**	
5.1	Classification Performance Evaluation Metrics: Accuracy, Precision, Precision, Recall, Specificity, False Positive Rate (FPR), F1 Score, Receiver Operator Characteristic (ROC) Curve, AUC	
5.2	Regression Performance Evaluation Metrics: Mean Absolute Error (MAE), Root Mean Squared Error (RMSE), R Squared/Coefficient of	

	Determination	
5.3	Clustering Performance Evaluation Metrics: Purity, Jaccard index, Normalized Mutual Information, Clustering Accuracy, Silhouette Coefficient, Dunn's Index	
5.4	Boosting: AdaBoost, gradient boosting machines.	
5.5	Resampling methods: cross-validation, bootstrap.	
5.6	Ensemble methods: bagging, boosting, random forests	
5.7	Practical aspects in machine learning: data preprocessing, overfitting, accuracy estimation, parameter and model selection	
5.8	Bias-Variance tradeoff	

Reference Books

1. Christopher Bishop. Neural Networks for Pattern Recognition, Oxford University Press, 1995.

2. Kevin P. Murphy. Machine Learning: A Probabilistic Perspective, MIT Press 2012.

3. Trevor Hastie, Robert Tibshirani, Jerome Friedman, The Elements of Statistical Learning, Second edition Springer 2007.

4. Ethem Alpaydin, Introduction to Machine Learning, 2nd edition, MIT Press 2010.

5. Tom Mitchell, Machine Learning, McGraw-Hill, 1997.

221TCS001	ADVANCED DATABASE MANAGEMENT	CATEGORY	L	T	P	CREDIT
		PROGRAM CORE 1	3	0	0	3

Preamble: This course provides an exposure to the concepts and techniques in advanced database management. Various strategies regarding query processing and optimization are discussed in this curriculum. An optimum insight of database security is provided. Different layouts of database system architecture and distributed system architecture, along with semi-structured data is included for better understanding of advanced data management. This course helps the learners to develop applications that manage data efficiently with the help of suitable data models and techniques.

Course Outcomes: After the completion of the course the student will be able to:

CO 1	Identify various measures of query processing and optimization. **(Cognitive Knowledge Level: Apply)**
CO 2	Analyze and implement security mechanisms to secure a database system. **(Cognitive Knowledge Level: Analyze)**
CO 3	Apply knowledge and awareness of the different database architectures in different scenarios. **(Cognitive Knowledge Level: Apply)**
CO 4	Analyze implementation aspects of distributed system on database architecture. **(Cognitive Knowledge Level: Analyze)**
CO 5	Make use of semi structured data, XML and XML queries for data management. **(Cognitive Knowledge Level: Apply)**
CO 6	Design, Develop, and Implement innovative ideas on advanced database concepts and techniques. **(Cognitive Knowledge Level: Create)**

Program Outcomes (PO)

Outcomes are the attributes that are to be demonstrated by a graduate after completing the course.

PO1: An ability to independently carry out research/investigation and development work in engineering and allied streams

PO2: An ability to communicate effectively, write and present technical reports on complex engineering activities by interacting with the engineering fraternity and with society at large.

PO3: An ability to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program

PO4: An ability to apply stream knowledge to design or develop solutions for real world problems by following the standards

PO5: An ability to identify, select and apply appropriate techniques, resources and state-of-the-art tool to model, analyse and solve practical engineering problems.

PO6: An ability to engage in life-long learning for the design and development related to the stream related problems taking into consideration sustainability, societal, ethical and environmental aspects

PO7: An ability to develop cognitive load management skills related to project management and finance which focus on Entrepreneurship and Industry relevance.

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
CO 1	✓		✓	✓		✓	
CO 2	✓		✓	✓		✓	
CO 3	✓		✓	✓		✓	
CO 4	✓		✓	✓		✓	
CO 5	✓		✓	✓	✓	✓	
CO 6	✓	✓	✓	✓	✓	✓	✓

Assessment Pattern

Bloom's Category	End Semester Examination
Apply	70%-80%
Analyze	30%-40%
Evaluate	
Create	

Mark distribution

Total Marks	CIE	ESE	ESE Duration
100	40	60	2.5 hours

Continuous Internal Evaluation Pattern:

Evaluation shall only be based on application, analysis or design-based questions (for both internal and end semester examinations).

Continuous Internal Evaluation : 40 marks

Micro project/Course based project : 20 marks

Course based task/Seminar/Quiz : 10 marks

Test paper, 1 no. : 10 marks

The project shall be done individually. Group projects not permitted.

Test paper shall include minimum 80% of the syllabus.

Course based task/test paper questions shall be useful in the testing of knowledge, skills, comprehension, application, analysis, synthesis, evaluation and understanding of the students.

End Semester Examination Pattern:

The end semester examination will be conducted by the University. There will be two parts; Part A and Part B. Part A contain 5 numerical questions with 1 question from each module, having 5 marks for each question. (such questions shall be useful in the testing of knowledge, skills, comprehension, application, analysis, synthesis, evaluation and understanding of the students). Students shall answer all questions.

Part B will contain 7 questions (such questions shall be useful in the testing of overall achievement and maturity of the students in a course, through long answer questions relating to theoretical/practical knowledge, derivations, problem solving and quantitative evaluation), with minimum one question from each module of which student should answer any five. Each question can carry 7 marks.

Total duration of the examination will be 150 minutes.

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Suppose you want to get answers to r ⋈ s sorted on an attribute of r, and want only the top K answers for some relatively small K. Give a good way of evaluating the query:
   i. When the join is on a foreign key of r referencing s, where the foreign key attribute is declared to be not null.
   ii. When the join is not on a foreign key.

2. Why is it not desirable to force users to make an explicit choice of a query processing strategy? Are there cases in which it is desirable for users to be aware of the costs of competing query-processing strategies? Explain your answer.

Course Outcome 2 (CO2):

1. A database relation may have the values of certain attributes encrypted for security. Why do database systems not support indexing on encrypted attributes? Using your answer to this question, explain why database systems do not allow encryption of primary-key attributes.

Course Outcome 3(CO3):

1. Suppose relation r is stored partitioned and indexed on A, and s is stored partitioned and indexed on B. Consider the query: $_{r.C}\gamma_{count(s.D)}((\sigma_{A>5}(r)) \bowtie_{r.B=s.B} s)$
   i Give a parallel query plan using the exchange operator, for computing the subtree of the query involving only the select and join operators.
   ii Now extend the above to compute the aggregate. Make sure to use preaggregation to minimize the data transfer.
2. If a parallel data-store is used to store two relations *r* and *s* and we need to join *r* and *s*, it may be useful to maintain the join as a materialized view. What are the benefits and overheads in terms of overall throughput, use of space, and response time to user queries? Explain in detail.

Course Outcome 4 (CO4):

1. Insert and query on a Bloom filter of size m = 10 and number of hash functions k= 3. Let H(x) denote the result of the three hash functions which will write as a set of three values {h 1 (x), h 2 (x), h 3 (x)} Has functions used: A= x mod 10, B= x mod 7, C= (sum of digits) mod 9.
2. Assume a relationship R_{AB} at site 1 and relationship S_{CD} at site 2 as follows: R= {(1,2), (3,4), (5, 6), (7, 8), (9, 10)}.S= {(1, 0), (8,1), (9, 2), (10, 3), (11, 4)}. Compute R⋈ S using bloom join with A=C and explain the intermediate steps. Show the tuples transferred with the hash function mod 4.

Course Outcome 5 (CO5):

1. Design an XML document for storing hostel mess food details (meals taken such as breakfast, lunch, dinner) with their charges for the month of June 2022. Charges may vary depending on the food taken. Students can opt not to take any meals on certain days.
   i Write a sample XML for 2 students for 2 days.
   ii Write a XQuery to return the lunch details of all.
   iii Create an XSD for the same.

Course Outcome 6 (CO6):

1. Implement Student book finder application using XML.

Model Question Paper

QP CODE:

Reg No: _____

Name: _____ **PAGES : 4**

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

FIRST SEMESTER M.TECH DEGREE EXAMINATION, MONTH & YEAR

Course Code: 221TCS001

Course Name: ADVANCED DATABASE MANAGEMENT

Max. Marks : 60 **Duration: 2.5 Hours**

PART A

Answer All Questions. Each Question Carries 5 Marks

1. Why is it not desirable to force users to make an explicit choice of a query-processing strategy? Are there cases in which it is desirable for users to be aware of the costs of competing query-processing strategies? Explain your answer. **(5)**

2. What are the relative merits of using Discretionary Access Control or Mandatory Access Control? What is role-based access control? In what ways is it superior to DAC and MAC? **(5)**

3. Suppose relation r is stored partitioned and indexed on A, and s is stored partitioned and indexed on B. Consider the query: $r.C\gamma_{count(s.D)}((\sigma_{A>5}(r)) \bowtie_{r.B=s.B}^{S})$ **(5)**

i Give a parallel query plan using the exchange operator, for computing the subtree of the query involving only the select and join operators.

ii Now extend the above to compute the aggregate. Make sure to use preaggregation to minimize the data transfer.

4. Insert and query on a Bloom filter of size m = 10 and number of hash functions k= 3. Let H(x) denote the result of the three hash functions which will write as a set of three values {h 1 (x), h 2 (x), h 3 (x)} **(5)**

Has functions used: A= x mod 10, B= x mod 7, C= (sum of digits) mod 9.

5. Design an XML document for storing hostel mess food details (meals taken such as breakfast, lunch, dinner) with their charges for the month of June 2022. Charges may vary depending on the food taken. Students can opt not to take any meals on certain days. **(5)**

i Write a sample XML for 2 students for 2 days.

ii Write a XQuery to return the lunch details of all.

iii Create an XSD for the same.

Part B

(Answer any five questions. Each question carries 7 marks)

6. (a) Consider the issue of interesting orders in optimization. Suppose you are given a query that computes the natural join of a set of relations S. Given a subset S1 of S, what are the interesting orders of S1? **(4)**

(b) Suppose you want to get answers to r ⋈ s sorted on an attribute of r, and want only the top K answers for some relatively small K. Give a good way of evaluating the query: **(3)**

i When the join is on a foreign key of r referencing s, where the foreign key attribute is declared to be not null.

ii When the join is not on a foreign key.

7. A database relation may have the values of certain attributes encrypted for security. Why do database systems not support indexing on encrypted attributes? Using your answer to this question, explain why database systems do not allow encryption of primary-key attributes. **(7)**

8. If a parallel data-store is used to store two relations *r* and *s* and we need to join *r* and *s*, it may be useful to maintain the join as a materialized view. What are the benefits and overheads in terms of overall throughput, use of space, and response time to user queries? Explain in detail. **(7)**

9. Consider the bitmap representation of the free-space map, where for each block in the file, two bits are maintained in the bitmap. If the block is between 0 and 30 percent full the bits are 00, between 30 and 60 percent the bits are 01, between 60 and 90 percent the bits are 10, and above 90 percent the bits are 11. Such bitmaps can be kept in memory even for quite large files. **(7)**

i Outline two benefits and one drawback to using two bits for a block, instead of one byte as described earlier in this chapter.

ii Describe how to keep the bitmap up to date on record insertions and deletions.

iii Outline the benefit of the bitmap technique over free lists in searching for free space and in updating free space information.

10. Assume a relationship R_{AB} at site 1 and relationship S_{CD} at site 2 as follows: **(7)**

R= {(1,2), (3,4), (5, 6), (7, 8), (9, 10)}

S= {(1, 0), (8,1), (9, 2), (10, 3), (11, 4)}

Compute R⋈ S using bloom join with A=C and explain the intermediate steps. Show the tuples transferred with the hash function mod 4.

11. (a) Consider the country data. **(4)**

Write XPath for the following:

i Return the area of India.

ii Return the names of all countries with population greater than 100 million.

iii Return the names of all countries whose population is less than one thousandth that of some city (in any country).

iv Return the names of all cities that have the same name as the country in which they are located.

(b) Consider the country data. **(3)**

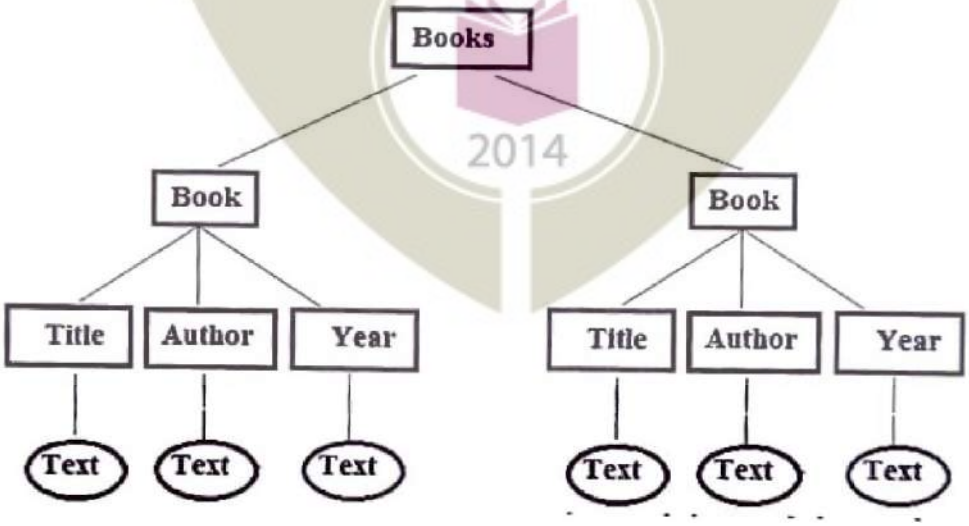
Write XQuery for the following:

i Return the name of the country with the highest population.

ii Return the name of the country that has the city with the highest population.

iii Return the average population of Russian-speaking countries.

12. Consider the following XML Tree **(7)**



Write an XML schema for the above, and also provide an XQuery expression to get the books published in the year 1992.

Syllabus

Module 1: Query Processing and Optimization

Review of indexing and Hashing - Overview- Measures of query cost- Algorithms for Selection and Join with cost analysis- Evaluation of expressions- Optimization of RA expressions**.**

Module 2: Database Security

Threats to databases, control measures, database security and DBA, Discretionary access control, Mandatory access control (role-based only), SQL injection.

Module 3: Database System Architectures

Centralized and Client-Server Architectures – Centralized server systems - Server System Architectures - Parallel Systems- - Parallel storage - Data partitioning, replication and indexing in Parallel Databases- Parallel query processing.

Module 4: Distributed System Architecture

Distributed System architecture- Distributed storage - Distributed file systems – Distributed RDB design- Transparency– Distributed Transactions - Commit Protocols – Concurrency Control - Distributed Query Processing
Advanced indexing Techniques: Bloom filter - Bitmap indices - Indexing spatial data - Hash indices.

Module 5: Semi-structured Data

Semi-structured Data and XML Databases: XML Data Model – XSD – XPath and XQuery – Example Queries. Native XML databases, Object Relational Systems

Course Plan

No	Topic	No. of Lectures (**40 Hours**)
1	**Module 1: Query Processing and Optimization**	**8**
1.1	Introduction to Query Processing and Optimization	1
1.2	Review of indexing	1
1.3	Hashing - Overview	1
1.4	Measures of query cost	1
1.5	Algorithms for Selection with cost analysis	1
1.6	Algorithms for Join with cost analysis	1
1.7	Evaluation of expressions	1
1.8	Optimization of RA expressions	1
2	**Module 2: Database Security**	**7**
2.1	Introduction to Database Security	1
2.2	Threats to databases	1
2.3	control measures	1
2.4	database security and DBA	1
2.5	Discretionary access control	1
2.6	Mandatory access control (role-based only)	1
2.7	SQL injection	1
3	**Module 3: Database System Architectures**	**9**
3.1	Introduction to Database System Architectures	1
3.2	Overview of Centralized and Client-Server Architectures	1
3.3	Centralized server systems	1
3.4	Server System Architectures	1
3.5	Parallel Systems	1
3.6	Parallel storage	1
3.7	Data partitioning, replication in Parallel Databases	1
3.8	Indexing in Parallel Databases	1
3.9	Parallel query processing.	1
4	**Module 4: Distributed System Architecture**	**10**
4.1	Introduction to Distributed System architecture	1

4.2	Distributed storage & Distributed file systems	1
4.3	Distributed RDB design & its Transparency	1
4.4	Distributed Transactions	1
4.5	Commit Protocols & Concurrency Control	1
4.6	Distributed Query Processing	1
4.7	Advanced indexing Techniques: Bloom filter	1
4.8	Bitmap indices	1
4.9	Indexing spatial data	1
4.10	Hash indices	1
5	**Module 5: Semi-structured Data**	**6**
5.1	Introduction to Semi-structured Data and XML Databases	1
5.2	XML Data Model – XSD	1
5.3	XPath and XQuery	1
5.4	Example Queries	1
5.5	Native XML databases	1
5.6	Object Relational Systems	1

References

1. R. Elmasri, S.B. Navathe, "Fundamentals of Database Systems", 7/e, Pearson Education/Addison Wesley, 2016
2. Thomas Cannolly and Carolyn Begg, "Database Systems, A Practical Approach to Design, Implementation and Management", 3/e, Pearson Education, 2010.
3. Henry F Korth, Abraham Silberschatz, S. Sudharshan, "Database System Concepts", 7/e, Tata McGraw Hill, 2019.
4. Joe Fawcett, Danny Ayers, Liam R. E. Quin, Beginning XML, 5/e, John Wiley & Sons, 2012
5. Grigoris Antoniou. Frank van Harmelen, "A Semantic Web Primer", The MIT Press,Cambridge, Massachusetts, 2003.

221TCS002	FOUNDATIONS OF COMPUTER SCIENCE	CATEGORY	L	T	P	CREDIT
		Program Core 2	3	0	0	3

Preamble: The purpose of this course is to develop rigorous proof writing skills which can be used to prove different theorems and results in Computer Science and its applications. This course helps to understand and apply the elementary and advanced Counting Principles in solving various computational problems. Also, the course helps the learners to solve problems on probability and also to understand a few classic probability problems.

Course Outcomes: After the completion of the course the student will be able to

CO 1	Apply Direct proof technique, Indirect proof technique and Mathematical Induction to prove various theorems and results. ((**Cognitive Knowledge Level: Apply)**
CO 2	Solve counting problems using Pigeon hole principle, Principle of Inclusion exclusion, Permutations, Combinations, Cantor's Diagonalization argument and Derangements. (**(Cognitive Knowledge Level: Apply)**
CO 3	Solve Recurrence relations and counting problems using Generating Functions. **(Cognitive Knowledge Level: Apply)**
CO 4	Solve problems on probability using the fundamentals of Probability, Bayes theorem, and Probability Distributions. **(Cognitive Knowledge Level: Apply)**
CO 5	Solve problems using concepts in algebraic structures such as Groups, Cosets and Lagrange's Theorem. **(Cognitive Knowledge Level: Apply)**
CO 6	Design solutions for various computational problems using the mathematical concepts of computer science and prove the correctness of the solution developed. **(Cognitive Knowledge Level: Evaluate)**

Program Outcomes (PO)

Outcomes are the attributes that are to be demonstrated by a graduate after completing the course.

PO1: An ability to independently carry out research/investigation and developmentwork in engineering and allied streams

PO2: An ability to communicate effectively, write and present technical reports on complex engineering activities by interacting with the engineering fraternity and with society at large.

PO3: An ability to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program

PO4: An ability to apply stream knowledge to design or develop solutions for real world problems by following the standards

PO5: An ability to identify, select and apply appropriate techniques, resources and state-of-the-art tool to model, analyse and solve practical engineering problems.

PO6: An ability to engage in life-long learning for the design and development related to the stream related problems taking into consideration sustainability, societal, ethical and environmental aspects

PO7: An ability to develop cognitive load management skills related to project management and finance which focus on Entrepreneurship and Industry relevance.

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
CO 1							
CO 2							
CO 3							
CO 4							
CO 5							
CO 6							

Assessment Pattern

Bloom's Category	End Semester Examination	
Apply	70%-80%	
Analyze	30%-40%	
Evaluate		
Create		

Mark distribution

Total Marks	CIE	ESE	ESE Duration
100	40	60	2.5 hours

Continuous Internal Evaluation Pattern:

Evaluation shall only be based on application, analysis or design based questions (for both internal and end semester examinations).

Continuous Internal Evaluation : 40 marks

Micro project/Course based project : 20 marks

Course based task/Seminar/Quiz : 10 marks

Test paper, 1 no. : 10 marks

The project shall be done individually. Group projects not permitted.

Test paper shall include minimum 80% of the syllabus.

Course based task/test paper questions shall be useful in the testing of knowledge, skills, comprehension, application, analysis, synthesis, evaluation and understanding of the students.

End Semester Examination Pattern:

The end semester examination will be conducted by the University. There will be two parts; Part A and Part B. Part A contain 5 numerical questions with 1 question from each module, having 5 marks for each question. (such questions shall be useful in the testing of knowledge, skills, comprehension, application, analysis, synthesis, evaluation and understanding of the students). Students shall answer all questions.

Part B will contain 7 questions (such questions shall be useful in the testing of overall achievement and maturity of the students in a course, through long answer questions relating to theoretical/practical knowledge, derivations, problem solving and quantitative evaluation), with minimum one question from each module of which student should answer any five. Each question can carry 7 marks.

Total duration of the examination will be 150 minutes.

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. For a ϵ Z, if $a^2 - 2a + 7$ is even, then a is odd. Prove the statement using contradiction and contrapositive proof techniques.

2. Assume that in a group of 6 people, each pair of individuals consists of 2 friends or 2 enemies. Show that there are either 3 mutual friends or 3 mutual enemies in the group. Every pair of people at the party are either friends or enemies.
3. Using the principle of mathematical induction prove that $6^{n+2} + 7^{2n+1}$ is divisible by 43 for $n \in Z^+$.

Course Outcome 2 (CO2):

1. How many different words can be formed from the letters of the word 'EXTRA" so that the vowels are never together?
2. Suppose repetitions are not allowed:

   (a) How many 3 digit numbers can be formed from the 6 digits 2,3,5,6,7 and 9?

   (b) How many of these numbers are less than 400?

   (c) How many are even?

Course Outcome 3(CO3):

1. Solve the recurrence relation using generating function: $a_r - 7a_{r-1} + 10a_{r-2} = 0$ with initial conditions $a_0=3$ and $a_1=3$.
2. Find the coefficient of x^{17} in the expansion of $(1 + x^5 + x^7)^{20}$.
3. Find the number of solutions of $e_1 + e_2 + e_3 = 17$,

   where e_1, e_2, and e_3 are nonnegative integers with $2 \leq e_1 \leq 5$, $3 \leq e_2 \leq 6$ and $4 \leq e_3 \leq 7$.

Course Outcome 4 (CO4):

1. Two marbles are drawn successively from a box of 3 black and 4 white marbles.

(i) Find the probability that both are black if the first marble is not replaced before the second drawing?

(ii) Find the probability that both are black if the first marble is replaced before the second drawing?

2. State Bayes Theorem.
3. Find the probability distribution of number of green balls drawn when 3 balls are drawn one by one without replacement from a bag containing 3 green and 5 white balls.

Course Outcome 5 (CO5):

1. A group of n men enter a restaurant and check their hats. The hat-checker is absent-minded, and upon leaving, she redistributes the hats back to the men at random. Find the expected number of men who get their own hat.
2. Explain (i) Generators of a group (ii) Left coset and (iii) Homomorphism with an example each.

Model Question Paper

QP CODE:

Reg No: _____

Name: _____ **PAGES : 2**

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

FIRST SEMESTER M.TECH DEGREE EXAMINATION, MONTH & YEAR

Course Code: 221TCS002

Course Name: FOUNDATIONS OF COMPUTER SCIENCE

Max. Marks : 60 **Duration: 2.5 Hours**

PART A

Answer All Questions. Each Question Carries 5 Marks

1.	Prove that √3 is irrational using proof by contradiction.	**(5)**
2.	Show that the set of real numbers is uncountable using Cantor's diagonalization principle.	**(5)**
3.	In how many different ways can eight identical cookies be distributed among three distinct children if each child receives at least two cookies and no more than four cookies?	**(5)**
4.	A woman has 11 close friends and she wants to invite 5 of them to dinner. In how many ways can she invite them if (i) there is no restriction on the choice. (ii) two particular persons will not attend separately. (iii) two particular persons will not attend together.	**(5)**
5.	State and prove Birthday Paradox.	**(5)**

Part B

(Answer any five questions. Each question carries 7 marks)

6. (a) Determine which amounts of postage can be formed using four and seven rupees stamps. Prove your answer using principle of mathematical induction . **(4)**

(b) Prove your answer using strong induction. **(3)**

7. Every sequence of $(n^2 + 1)$ distinct real numbers contain a sub sequence of length $(n + 1)$ that is either strictly increasing or strictly decreasing. Prove the statement using Pigeonhole principle. **(7)**

8. (a) (i)Find the number of permutations that can be formed from the letters of the string 'ELEVEN'? **(4)**

(ii) How many of them begin and end with E?

(iii) How many of them have three Es together?

(iv) How many begin with E and end with N?

(b) Determine the number of integers between 1 and 10000 that are not divisible by 6, 7 or 8. **(3)**

9. Solve the recurrence relation $a_n - 4a_{n-1} = 6 \times 4^n$ with initial condition $a_0 = 1$, using generating function. **(7)**

10. Entry to a certain University is determined by a national test. The scores on this test are normally distributed with a mean of 500 and a standard deviation of 100. Tom wants to be admitted to this university and he knows that he must score better than at least 70% of the students who took the test. Tom takes the test and scores 585. Will he be admitted to this university? Why? **(7)**

11. There are n distinct coupons placed in an urn. Coupons are randomly selected one at a time (with replacement) until at least one of each type of coupon has been selected. Find the expected number of selections made until all distinct n coupons are collected. **(7)**

12. State and prove Lagrange's Theorem. **(7)**

Syllabus

Module 1: Theorem Proving Techniques

Theorem proving techniques: Direct Proof, Indirect proof - Proof by Contrapositive, Proof by contradiction and Proof by exhausting cases, Principle of mathematical induction, Complete induction and Well-ordering principle. The Pigeonhole principle.

Module 2 : Fundamentals of Counting

The Basics of counting, Addition and multiplication principles, Permutations and Combinations. Countable and uncountable sets, Principle of inclusion and exclusion – applications, derangements.

Module 3 : Generating Functions

Recurrence Relations, Modeling problems with recurrence relations. Generating functions, Solving counting problems using Generating functions, Solving recurrence relations using Generating functions.

Module 4: Probability Theory

Probability theory – Properties of Probability, Conditional Probability, Independent Events, Bayes Theorem, Mathematical Expectation and Variance of Random variables.

Discrete Distributions and its mean and variance- Binomial Distribution, Bernoulli Distribution , Geometric Distribution, Poisson Distribution. Continuous Distributions and its mean and variance- Uniform and Exponential Distributions, Normal Distribution.

Module 5 : Classic Problems in Probability and Algebraic Structures

Classic Problems in Probability- Birthday Paradox, The Hat Problem, Coupon Collector Problem.

Groups and subgroups, generators for a group, Homomorphism theorems, cosets and normal subgroups, Lagrange's theorem.

Course Plan

No	Topic	No. of Lectures (40 hrs)
1	**Module 1: Theorem Proving Techniques**	**8**
1.1	Theorem proving techniques: Direct Proof	1
1.2	Indirect proof - Proof by Contrapositive,	1
1.3	Proof by contradiction	1
1.4	Principle of mathematical induction, Complete induction	1
1.5	Principle of mathematical induction, Complete induction	1
1.6	Well-ordering principle	1
1.7	The Pigeonhole principle	1
1.8	The Pigeonhole principle	1
2	**Module 2: Fundamentals of Counting**	**7**
2.1	The Basics of counting, Addition and multiplication principles	1
2.2	Permutations and Combinations.	1
2.3	Permutations and Combinations.	1
2.4	Countable and uncountable sets	1
2.5	Countable and uncountable sets	1
2.6	Principle of inclusion and exclusion –applications,	1
2.7	Derangements	1
3	**Module 3: Generating Functions**	**7**
3.1	Recurrence Relations, Modeling problems with recurrence relations.	1
3.2	Generating functions	1

3.3	Generating functions	1
3.4	Solving counting problems using Generating functions	1
3.5	Solving counting problems using Generating functions	1
3.6	Solving recurrence relations using Generating functions.	1
3.7	Solving recurrence relations using Generating functions.	1
4	**Module 4: Probability Theory**	**10**
4.1	Probability theory – Properties of Probability	1
4.2	Conditional Probability	1
4.3	Independent Events	1
4.4	Bayes Theorem	1
4.5	Mathematical Expectation and Variance of Random variables	1
4.6	Discrete Distributions and its mean and variance- Binomial Distribution, Bernoulli Distribution	1
4.7	Geometric Distribution, Poisson Distribution	1
4.8	Continuous Distributions and its mean and variance	1
4.9	Uniform and Exponential Distributions	1
4.10	Normal Distribution	1
5	**Module 5: Classic Problems in Probability and Algebraic Structures**	**8**
5.1	Classic Problems in Probability- Birthday Paradox	1
5.2	The Hat Problem	1
5.3	Coupon Collector Problem.	1
5.4	Coupon Collector Problem.	1
5.5	Groups and subgroups, generators for a group	1
5.6	Homomorphism theorems	1

5.7	Cosets and normal subgroups	1
5.8	Lagrange's theorem	1

References

1. Kenneth H. Rosen, "Discrete Mathematics and its Applications" 7/e, McGraw Hill Inc, 2011.

2. J. P. Tremblay, R. Manohar, "Discrete Mathematical Structures with Application to Computer Science" Tata McGrawHill, 2000

3. Sheldon M. Ross, "Introduction to Probability Models"

4. Sheldon M. Ross, "A First Course in Probability"

5. William Feller, "An introduction to probability theory and its applications" Volume1.Wiley,1957.

6. Rajeev Motwani and Prabhakar Raghavan, "Randomized Algorithms" Cambridge University Press 1995

221ECS100	OBJECT ORIENTED SOFTWARE ENGINEERING	CATEGORY	L	T	P	CREDIT
		PROGRAM ELECTIVE 1	3	0	0	3

Preamble: Study of this course provides the learners an exposure to the concepts and principles of object-oriented software engineering. The course covers the various software lifecycle models, principles of design, coding, testing, maintenance and configuration management. The course helps the learners to analyse and design software using tools and will improve capability to efficiently develop, deploy and maintain software.

Course Outcomes: After the completion of the course the student will be able to

CO 1	Make use of project organization and management concepts and analyse the various tasks carried out. **(Cognitive Level: Apply)**
CO 2	Identify and select suitable process model for a given problem. **(Cognitive Level: Apply)**
CO 3	Analyse the requirements of a given software project and produce requirement specification **(Cognitive Level: Analyse).**
CO 4	Examine the various designing principles and patterns of a software product**. (Cognitive Level: Analyse)).**
CO 5	Build the mapping of product design to code, its testing and maintenance. **(Cognitive Level: Apply).**
CO6	Design, analyse object models and dynamic models for a given problem statement. **(Cognitive Level: Create)**

Program Outcomes (PO)

Outcomes are the attributes that are to be demonstrated by a graduate after completing the course.

PO1: An ability to independently carry out research/investigation and development work in engineering and allied streams

PO2: An ability to communicate effectively, write and present technical reports on complex engineering activities by interacting with the engineering fraternity and with society at large.

PO3: An ability to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program

PO4: An ability to apply stream knowledge to design or develop solutions for real world problems by following the standards

PO5: An ability to identify, select and apply appropriate techniques, resources and state-of-the-art tool to model, analyse and solve practical engineering problems.

PO6: An ability to engage in life-long learning for the design and development related to the stream related problems taking into consideration sustainability, societal, ethical and environmental aspects

PO7: An ability to develop cognitive load management skills related to project management and finance which focus on Entrepreneurship and Industry relevance.

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
CO 1	✓		✓	✓	✓	✓	
CO 2	✓		✓	✓	✓		
CO 3	✓		✓	✓	✓		
CO 4	✓		✓	✓	✓		
CO 5	✓		✓	✓	✓	✓	
CO 6	✓	✓	✓	✓	✓	✓	✓

Assessment Pattern

Bloom's Category	End Semester Examination
Apply	70%-80%
Analyse	30%-40%
Evaluate	
Create	

Mark distribution

Total Marks	CIE	ESE	ESE Duration
100	40	60	2.5 hours

Continuous Internal Evaluation Pattern:

Evaluation shall only be based on application, analysis or design based questions (for both internal and end semester examinations).

Continuous Internal Evaluation: 40 marks

i. Preparing a review article based on peer reviewed original publications (minimum 10 publications shall be referred) : 15 marks

ii. Course based task / Seminar/ Data collection and interpretation : 15 marks

iii. Test paper (1 number) : 10 marks

Test paper shall include minimum 80% of the syllabus.

Course based task/test paper questions shall be useful in the testing of knowledge, skills, comprehension, application, analysis, synthesis, evaluation and understanding of the students.

End Semester Examination Pattern:

The end semester examination will be conducted by the respective College.

There will be two parts; Part A and Part B.

Part A will contain 5 numerical/short answer questions with 1 question from each module, having 5 marks for each question. Students should answer all questions. Part B will contain 7 questions (such questions shall be useful in the testing of overall achievement and maturity of the students in a course, through long answer questions relating to theoretical/practical knowledge, derivations, problem solving and quantitative evaluation), with minimum one question from each module of which student should answer any five. Each question can carry 7 marks

Total duration of the examination will be 150 minutes.

Note: The marks obtained for the ESE for an elective course shall not exceed 20% over the average ESE mark % for the core courses. ESE marks awarded to a student for each elective course shall be normalized accordingly.

For example if the average end semester mark % for a core course is 40, then the maximum eligible mark % for an elective course is 40+20 = 60 %.

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Detail about the Project Organisation Concepts.
2. Distinguish between planned and unplanned communication.
3. Can a role be shared between two or more participants? Why or why not?

Course Outcome 2 (CO2):

1. Analyse the various Life cycle models

2. Compare the Sequential Activity Centered model with the Iterative Activity Centered models.

Course Outcome 3(CO3):

1. Draw a class diagram representing a book defined by the following statement: "A book is composed of a number of parts, which in turn are composed of a number of chapters. Chapters are composed of sections." Focus only on classes and relationships.

2. Conduct requirement elicitation for a social media application.

Course Outcome 4 (CO4):

1. Cohesion and coupling controls the complexity of a system during subsystem decomposition. Illustrate using example.

2. Compare and contrast Dynamic Object Modelling with Static Object modelling.

Course Outcome 5 (CO5):

1. Discuss the configuration management concepts of a system.

2. Explain why maintenance is unavoidable in the field of software.

Course Outcome 6 (CO6):

1. Consider the problem statement of an E-commerce application:
   a. Analyse the requirements and design the different UML diagrams
   b. Create the necessary test cases so as to conduct functional testing on the application.

Model Question Paper

QP CODE:

Reg No: _____

Name: _____ **PAGES : 2**

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

FIRST SEMESTER M.TECH DEGREE EXAMINATION, MONTH & YEAR

Course Code: 221ECS100

Course Name: OBJECT ORIENTED SOFTWARE ENGINEERING

Max. Marks : 60 **Duration: 2.5 Hours**

PART A

Answer All Questions. Each Question Carries 5 Marks

1.	Being the member of the design team to develop an interface for an online registration portal, you are not sure about the mandatory fields. People in what role can help you out. Whether planned or unplanned communication will be more beneficial in this situation. Why?	**(5)**
2.	For what type of project, the spiral model suit's best. Why?	**(5)**
3.	Describe the different Requirement Elicitation techniques.	**(5)**
4.	Discuss the design Principles of System Design.	**(5)**
5.	Demonstrate the different steps of software deployment.	**(5)**

Part B

(Answer any five questions. Each question carries 7 marks)

6.	(a)	Explain Work Breakdown Structure.	**(3)**
	(b)	What are the types of project organizations?	**(4)**
7.	(a)	Explain Iterative Activity Centered Models.	**(3)**
	(b)	Explain Agile process?	**(4)**

8. Problem statement: Student Attendance Monitoring System. **(7)**

Student Attendance Monitoring System is used to track the attendance of students in an Institute. Faculty advisor can add students into the system, which is verified and approved by HOD. Once the students list is approved, the teachers can mark attendance on the system. Students can apply for duty leaves to the faculty advisor. Faculty advisor forwards the application to the HOD for approval. Students, teachers, faculty advisor and HOD can view the attendance reports of every student.

Draw the sequence diagram for this problem statement.

9. (a) Identify any four functional and non-functional requirements of KTU website. **(4)**

(b) Compare the Dynamic Object Modelling with the Static Object Modelling **(3)**

10. (a) Design patterns speed up the development process quiet a lot. Illustrate with example. **(3)**

(b) Discuss about the Object Constraint Language? **(4)**

11. (a) Discuss System Documentation **(3)**

(b) What is skill matrix? Briefly describe the project management activities? **(4)**

12. (a) Consider a method that will return the fare of a transport bus, given the source, destination and number of passengers. The source and destination are specified as integers. 1 represents station A, 2 represents station B etc. The total number of seats is 30. Generate test cases for Unit testing the system. **(4)**

(b) List out the benefits of model transformation. **(3)**

Syllabus

Module 1: Classical Paradigm

System Design Concepts – Project Organization Concepts : Project Organizations , Roles , Tasks and Work Products ,Schedule – Project Communication concepts : Planned Communication , Unplanned Communication ,Communication Mechanism – Project Management Concepts : Tasks and Activities ,Work Products , Work Packages and Roles , Work Breakdown Structure .

Module 2: Process Models

Life cycle models: Sequential Activity Centered Models, Iterative Activity Centered models, Entity Centered models – Unified Process – Iterative and Incremental – Workflow – Agile Processes

Module 3: Analysis

Requirements Elicitation Concepts – An Overview of Unified Modeling Language –Analysis Concepts : Analysis Object Model and Analysis Dynamic Models – Non-functional requirements – Analysis Patterns – Executable specification

Module 4: Design

System Design, Architecture – Design Principles - Design Patterns – Dynamic Object Modeling Static Object Modeling – Model based approach vs Document based approach – Interface Specification – Object Constraint Language

Module 5: Implementation, Deployment And Maintenance

Mapping Design (Models) to Code – Testing - Usability – Deployment – Configuration Management – Maintenance

Course Plan

No	Topic	No. of Lectures (40 Hours)
1	**Module 1: Classical Paradigm**	**10**
1.1	System Design Concepts	1
1.2	Project Organization Concepts- Project Organizations	1
1.3	Roles , Tasks, Work Products and Schedule	1
1.4	Project Communication concepts	1

1.5	Planned Communication , Unplanned Communication .	1
1.6	Communication Mechanism	1
1.7	Project Management Concepts	1
1.8	Tasks and Activities ,Work Products ,	1
1.9	Work Packages and Roles	1
1.10	Work Breakdown Structure	1
2	**Module 2: Process Models**	**8**
2.1	Life cycle models	1
2.2	Sequential Activity Centered Models	1
2.3	Iterative Activity Centered models	1
2.4	Entity Centered models	1
2.5	Unified Process	1
2.6	Iterative and Incremental	1
2.7	Workflow	1
2.8	Agile Processes	1
3	**Module 3: Analysis**	**7**
3.1	Requirements Elicitation Concepts	1
3.2	An Overview of Unified Modeling Language	1
3.3	Analysis Concepts	1
3.4	Analysis Object Model and Analysis Dynamic Models	1
3.5	Non-functional requirements	1
3.6	Analysis Patterns	1
3.7	Executable specification	1
4	**Module 4: Design**	**8**
4.1	System Design, Architecture	1
4.2	Design Principles	1
4.3	Design Patterns	1
4.4	Dynamic Object Modeling	1
4.5	Static Object Modeling	1
4.6	Model based approach vs Document based approach	1
4.7	Interface Specification	1
4.8	Object Constraint Language	1

5	**Module 5: Implementation, Deployment And Maintenance**	**7**
5.1	Mapping Design (Models) to Code	1
5.2	Mapping Design (Models) to Code(Continued)	1
5.3	Testing	1
5.4	Usability	1
5.5	Deployment	1
5.6	Configuration Management	1
5.7	Maintenance	1

References

1. Bernd Bruegge, Alan H Dutoit, Object-Oriented Software Engineering, 2nd edition, Pearson Education, 2004.

2. Craig Larman, Applying UML and Patterns 3rd edition, Pearson Education, 2005

3. Stephen Schach, Software Engineering 7th ed, McGraw-Hill, 2007.

4. Ivar Jacobson, Grady Booch, James Rumbaugh, The Unified Software Development Process, Pearson Education, 1999.

5. Alistair Cockburn, Agile Software Development 2nd ed, Pearson Education.

221ECS001	ADVANCED DATA MINING	CATEGORY	L	T	P	CREDIT
		PROGRAM ELECTIVE 1	3	0	0	3

Preamble: This course provides exposure to the concepts, principles and techniques of data mining. This course will enable the learners to identify the key process of Data mining and Warehousing, apply appropriate techniques to convert raw data into suitable format for practical data mining tasks, apply various data mining algorithms in appropriate domain, analyze the performance using performance metrics and extend data mining methods to the new domains of data. This course also helps to develop Data Mining systems which can analyze data efficiently and rigorously with suitable data models and techniques for respective applications.

Course Outcomes: After the completion of the course the student will be able to

CO 1	Summarise basic concepts of Data mining and Illustrate feature vector representation for a given data collection **(Cognitive Knowledge Level: Understand)**
CO 2	Design Data Warehouse for problems in various domains. **(Cognitive Knowledge Level: Apply)**
CO 3	Implement Association Rules for analysing Transactional databases **(Cognitive Knowledge Level: Apply)**
CO4	Implement major Classification and Clustering Algorithms to a given problem. **(Cognitive Knowledge Level: Analyze)**
CO 5	To develop Data Mining system and analyze the performance (**Cognitive Knowledge Level: Create)**

Program Outcomes (PO)

Outcomes are the attributes that are to be demonstrated by a graduate after completing the course.

PO1: An ability to independently carry out research/investigation and development work in engineering and allied streams

PO2: An ability to communicate effectively, write and present technical reports on complex engineering activities by interacting with the engineering fraternity and with society at large.

PO3: An ability to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program

PO4: An ability to apply stream knowledge to design or develop solutions for real world problems by following the standards

PO5: An ability to identify, select and apply appropriate techniques, resources and state-of-the-art tool to model, analyse and solve practical engineering problems.

PO6: An ability to engage in life-long learning for the design and development related to the stream related problems taking into consideration sustainability, societal, ethical and environmental aspects

PO7: An ability to develop cognitive load management skills related to project management and finance which focus on Entrepreneurship and Industry relevance.

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
CO 1	✓		✓			✓	
CO 2	✓		✓			✓	
CO 3	✓		✓	✓	✓	✓	
CO 4	✓		✓	✓	✓	✓	
CO 5	✓	✓	✓	✓	✓	✓	✓

Assessment Pattern

Bloom's Category	End Semester Examination
Apply	70%-80%
Analyze	30%-40%
Evaluate	
Create	

Mark distribution

Total Marks	CIE	ESE	ESE Duration
100	40	60	2.5 hours

Continuous Internal Evaluation Pattern:

Evaluation shall only be based on application, analysis or design-based questions (for both internal and end semester examinations).

Continuous Internal Evaluation: 40 marks

i. Preparing a review article based on peer reviewed original publications (minimum 10 publications shall be referred) : 15 marks

ii. Course based task / Seminar/ Data collection and interpretation : 15 marks

iii. Test paper (1 number) : 10 marks

Test paper shall include minimum 80% of the syllabus.
Course based task/test paper questions shall be useful in the testing of knowledge, skills, comprehension, application, analysis, synthesis, evaluation and understanding of the students.

End Semester Examination Pattern:

The end semester examination will be conducted by the respective College.

There will be two parts; Part A and Part B.

Part A will contain 5 numerical/short answer questions with 1 question from each module, having 5 marks for each question. Students should answer all questions. Part B will contain 7 questions (such questions shall be useful in the testing of overall achievement and maturity of the students in a course, through long answer questions relating to theoretical/practical knowledge, derivations, problem solving and quantitative evaluation), with minimum one question from each module of which student should answer any five. Each question can carry 7 marks

Total duration of the examination will be 150 minutes.

Note: The marks obtained for the ESE for an elective course shall not exceed 20% over the average ESE mark % for the core courses. ESE marks awarded to a student for each elective course shall be normalized accordingly.

For example, if the average end semester mark % for a core course is 40, then the maximum eligible mark % for an elective course is 40+20 = 60 %.

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Implement an intelligent disease prediction system using feature selection techniques
2. Discuss different data reduction techniques with example
3. Implement an intrusion detection system using feature selection techniques
4. Discuss how mapping is done for different types of raw data to ML features with example
5. How we can eliminate noise using clustering? Discuss with example
6. Distinguish between cluster sampling and stratified sampling techniques with example

Course Outcome 2 (CO2):

1. Differentiate between Stars, Snowflakes and Fact constellation schemas
2. Suppose that a data warehouse consists of the dimensions time, branch, dealer, location and product, and the two measures unit-sold and revenue. Draw a star schema diagram and snowflake schema diagram for the data warehouse. Provide DMQL representation of star schema diagram and snowflake schema
3. List different schemas for a Data Warehouse Suppose that a Data Warehouse for Big University consists of the following four dimensions: student, course, semester and instructor and two measures count, avg_grade. When at the lowest conceptual level (e.g for a given student, course, semester and instructor combination), the avg_grade measure stores the actual course grade of the student. At higher conceptual levels avg_grade stores the average grade for the given combination. a) Draw the Snowflake schema diagram for the data warehouse b) Starting with the base cuboid [student, course, semester, instructor) what specific OLAP operations should one perform in order to list the average grade of CS courses for each Big University student.
4. What is the difference between BigQuery and Snowflake? What are the different ways to access the BigQuery Cloud Data warehouse ?
5. What are the data security features in Bigquery ?

Course Outcome 3(CO3):

1. Discuss Bayesian Networks and Data Modeling with an example
2. Implement spam filtering, Image enhancement using Bayesian Networks
3. Compare the R-tree to the R*-tree Discuss different spatial datamining primitives with example
4. Investigate and describe two techniques which have been used to predict future stock prices.
5. Apply the Apriori algorithm for discovering frequent itemsets from the following data set minimum support of 50% and minimum confidence of 75%.

Transaction ID	Items
100	Bread, Cheese
200	Bread, Cheese, Juice
300	Bread, Milk
400	Cheese, Juice. Milk

Course Outcome 4 (CO4):

1. Suppose a data collection consists of customer data of a bank. Implement customer fraud detection system
2. Suppose a corpus consists of data from medical domain. Implement a disease prediction system
3. Implement a Data Mining system to detect intrusions that may harm the database to offer greater security to the entire system.

Course Outcome 5 (CO5):

1. Implement a Data Mining system to assist Mobile service providers to design their marketing campaigns and to retain customers from moving to other vendors.
   Data collection consists of billing information, email, text messages, web data transmissions, and customer service and so on. The data mining system has to predict "churn" that tells the customers who are looking to change the vendors. The mobile service providers are then able to provide incentives, offers to customers who are at higher risk of churning.

Model Question Paper

QP CODE:

Reg No: _____

Name: _____ **PAGES: 3**

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

FIRST SEMESTER M.TECH DEGREE EXAMINATION, MONTH & YEAR

CODE 221ECS001

Course Name: ADVANCED DATA MINING

Max. Marks : 60 **Duration: 2.5 Hours**

PART A

Answer All Questions. Each Question Carries 5 Marks

1.	Differentiate between classification and regression with example	**(5)**
2.	Explain concept hierarchy generation. With a suitable example show how is it done for categorical data.	
3.	How can you generate association rules from frequent item sets?	**(5)**
4.	Why are nearest neighbor algorithms called lazy learners? What are the disadvantages of a lazy learner?	**(5)**
5.	How do we relate text mining and web mining? Differentiate between spatial and non spatial data with example	**(5)**

Part B

(Answer any five questions. Each question carries 7 marks)

6.	(a)	Why feature engineering is important? What is the output of feature engineering in machine learning?	**(3)**
	(b)	Suppose that the data for analysis includes the attribute age. The age values for the data tuples are (in increasing order) 13, 15, 16, 16, 19, 20, 20, 21, 22, 22, 25, 25, 25, 25, 30, 33, 33, 35, 35, 35, 35, 36, 40, 45, 46, 52, 70. i) Use smoothing by bin means to smooth the above data, using a bin depth of 3. Illustrate your steps. ii) How might you determine outliers in the data	**(4)**
7.	(a)	How do data warehousing relate to data mining? Discuss	**(3)**

(b) Suppose that a data warehouse consists of the three dimensions time, doctor, and patient, and the two measures count and charge, where charge is the fee that a doctor charges a patient for a visit. **(4)**

a) List three classes of schemas that are popularly used for modeling data warehouses.

b) Draw a schema diagram for the above data warehouse using one of the schema classes listed in(a).

Starting with the base cuboid [day,doctor,patient],what a specific OLAP operations should be performed in order to list the total fee collected by each doctor in 2022?

8. (a) Why is the FP growth algorithm so efficient? **(3)**

(b) Discuss FP growth algorithm. Using Apriori and FP growth algorithm find the frequent itemsets from the following transactional database? (min_sup= 2, confidence 70%). Compare the two processes **(4)**

TID	List of item-IDs
T100	I1,I2,I3
T200	I2,I4
T300	I2,I3
T400	I1,I2,I4
T500	I1,I3
T600	I2,I3
T700	I1,I3
T800	I1,I2,I3,I5
T900	I1,I2,I3

9. (a) What is the metric for classification tasks in CART? How to use the CART algorithm for classification **(3)**

(b) Differentiate between different types of ensemble methods for classification with example **(4)**

10. (a) How is the parameter "Distance-function" estimated in the DBSCAN Algorithm? What are the advantages and disadvantages of DBSCAN algorithm **(3)**

(b) What is the purpose of cluster ensemble? How do you create a cluster ensemble**?** Discuss with example **(4)**

Syllabus

Module 1: Data Mining and Knowledge Discovery

Desirable Properties of Discovered Knowledge – Knowledge representation, Data Mining Functionalities, Motivation and Importance of Data Mining, Classification of Data Mining Systems, Integration of a Data Mining System with a Database or Data Warehouse System, Classification, Clustering, Regression, Data Pre-processing: Data Cleaning, Data Integration and Transformation, normalization, standardization, Data Reduction, Feature vector representation. importance of feature engineering in machine learning; forward selection and backward selection for feature selection; curse of dimensionality; data imputation techniques; No Free Lunch theorem in the context of machine learning, Data Discretization and Concept Hierarchy Generation

Module 2: Data Warehouse and OLAP Technology for Data Mining

Data warehouses and its Characteristics - Data warehouse Architecture and its Components, Data Warehouse Design Process, Data Warehouse and DBMS, Data marts, Metadata, Data Cube and OLAP, Extraction - Transformation – Loading - Schemas for Multidimensional Database: Stars, Snowflakes and Fact constellations, OLAP Cube - OLAP Operations - OLAP Server Architecture - Data Warehouse Implementation - From Data Warehousing to Data Mining, Trends in data warehousing

Module 3: Association Pattern Mining

Mining Frequent Patterns, Associations and Correlations –Mining Methods – Mining Various Kinds of Association Rules – Correlation Analysis – Constraint Based Association Mining, Single Dimensional Boolean Association Rules From Transaction Databases, Multilevel Association Rules from transaction databases – Multi dimension Association Rules from Relational Database and Data Warehouses, Frequent Item Set Generation, Apriori Algorithm, Improved Apriori Algorithm for Association Rules Mining, Methods to improve Apriori, FP Growth Algorithm - Generating association rules from frequent itemset, Compact Representation of Frequent Item set - Maximal Frequent Item Set - Closed Frequent Item Sets. Pattern Evaluation Methods- Relationship Between FP-Growth and Enumeration-Tree Methods From Association Analysis to Correlation Analysis, Lift

Module 4: Classification and Prediction

Classification Techniques, Decision Tree - Decision tree Construction, Measures for Selecting the Best Split - Algorithm for Decision tree Induction - CART, Bayesian Belief Networks, Instance-Based Learning, K-Nearest neighbor classification, Accuracy and Error measures, Multiclass Classification, Semi-Supervised Classification, Multi class Learning, Rare class learning, Active Learning, Transfer Learning, Fuzzy Set Approaches for Classification, Rough Set Approaches, Techniques to improve classification accuracy-Ensemble methods, Bias-Variance Trade-off, Improving classification accuracy of class imbalanced data

Module 5: Cluster Analysis

Desired features of cluster Analysis, Types of data in cluster analysis, Categorization of Major Clustering Methods, Density-Based Methods, Clustering High Dimensional Data, Constraint Based Cluster Analysis, GA based clustering, Dealing with Large Databases, Probabilistic Model Based Clustering, Clustering with Constraints, Semi supervised clustering, Cluster Ensembles, Quality and validity of cluster analysis methods, Outlier Analysis-Statistical Approaches, Proximity Based Approaches

Advanced Mining: Multimedia Data Mining - Text Mining, Graph Mining and Social Network Analytics - Geospatial Data Mining, Temporal Mining, Data Mining Applications - Social Impacts of Data Mining.

Course Plan

No	Topic	No. of Lectures (**40 Hours**)
1	**Module 1: Data Mining and Knowledge Discovery**	**6**
1.1	Data Mining Functionalities, Motivation and Importance of Data Mining	1
1.2	Integration of a Data Mining System with a Database or Data Warehouse System, Major Issues in Data Mining. Classification, Clustering, Regression	1
1.3	Data Pre-processing: Data Cleaning, Data Integration and Transformation, normalization	1
1.4	Data Reduction, Different techniques	1
1.5	Feature vector representation. importance of feature engineering in machine learning;	1
1.6	Forward selection and backward selection for feature selection;	1
2	**Module 2: Data Warehouse and OLAP Technology for Data Mining**	**7**
2.1	Data warehouses and its Characteristics - Data warehouse Architecture and its Components	1
2.2	Data Warehouse and DBMS, Data marts, Metadata Extraction - Transformation – Loading in DW,	1
2.3	Multidimensional model	1

2.4	Schemas for Multidimensional Database: Stars, Snowflakes Fact constellations	1
2.5	Design Data Warehouse for problems in different domains	1
2.6	OLAP Cube - OLAP Operations	1
2.7	OLAP Server Architecture - Data Warehouse Implementation	1
3	**Module 3: Association Rule Mining**	**7**
3.1	Mining Frequent Patterns, Associations and Correlations	1
3.2	Mining Various Kinds of Association Rules – Correlation Analysis – Constraint Based Association Mining	1
3.3	Multilevel Association Rules from transaction databases – Multi dimension Association Rules from Relational Database and Data Warehouses	1
3.4	Frequent Item Set Generation, Apriori Algorithm, Apriori Algorithm- illustration with example	1
3.5	Methods to improve Apriori, FP Growth Algorithm	1
3.6	FP Growth Algorithm- illustration with example, Compact Representation of Frequent Item set	1
3.7	Pattern Evaluation Methods, Association Analysis to Correlation Analysis, Lift	1
4	**Module 4: Classification and Prediction**	**10**
4.1	Classification Techniques, Decision Tree - Decision tree Construction Measures for Selecting the Best Split	1
4.2	Decision tree Induction - illustration with example Algorithm for Decision tree Induction - CART	1
4.3	Bayesian Belief Networks	1
4.4	Bayesian Belief Networks- Training	1
4.5	K-Nearest neighbor classification, Accuracy and Error measures	1
4.6	Multiclass Classification, Semi-Supervised Classification	1
4.7	Active Learning, Transfer Learning	1
4.8	Fuzzy Set Approaches for Classification	1
4.9	Rough Set Approaches	1

4.10	Ensemble methods. Improving classification accuracy of class imbalanced data	1
5	**Module 5: Cluster Analysis**	**10**
5.1	Desired features of cluster Analysis, Types of data in cluster analysis,	1
5.2	Categorization of Major Clustering Methods, Density-Based Methods,	1
5.3	Semi supervised clustering, Clustering High Dimensional Data, Constraint Based Cluster Analysis,	1
5.4	GA based clustering	1
5.5	Probabilistic Model Based Clustering	1
5.6	Quality and validity of cluster analysis methods, Outlier Analysis-Statistical Approaches, Proximity Based Approaches	1
5.7	Multimedia Data Mining	1
5.8	Text Mining	1
5.9	Graph Mining and Social Network Analytics	1
5.10	Geospatial Data Mining, Temporal Mining	1

References

1. Kevin Murphy, Machine Learning: A Probabilistic Perspective (MLAPP), MIT Press, 2012
2. Christopher Bishop, Pattern Recognition and Machine Learning (PRML), Springer, 2007.
3. Jiawei Han, Micheline Kamber, Jian Pei, "Data Mining: Concepts and Techniques", Morgan Kaufmann, 2nd Ed., 2005
4. Charu C. Aggarwal ,Data Mining, Springer, ISBN 978-3-319-14141-1,2015
5. Data Mining Techniques,Arun K Puari, Universities Press,2001
6. Margaret H. Dunham, "Data Mining: Introductory and Advanced Topics", Prentice Hall, 1st Ed., 2002.
7. David G. Stork, Peter E. Hart, and Richard O. Duda. Pattern Classification (PC), Wiley-Blackwell, 2000
8. Trevor Hastie, Robert Tibshirani, Jerome Friedman, The Elements of Statistical Learning (ESL), Springer, 2009
9. G. K. Gupta "Introduction to Data Mining with Case Studies", Eastern Economy Edition, Prentice Hall of India, 2006.

10. Soumen Chakrabarti, "Mining the Web: Discovering Knowledge from Hypertext Data", Morghan Kaufmann, 1st Ed., 2005.
11. Da Ruan, Guoqing Chen, Etienne E. Kerre, Geert Wets, “Intelligent Data Mining: Techniques and Applications (Studies in Computational Intelligence)”, Springer, 1st Ed., 2010.
12. Masoud Mohammadian, “Intelligent Agents for Data Mining and Information Retrieval”, Idea Group Publishing, 2004.
13. I. H. Witten and E. Frank. Data Mining: Practical Machine Learning Tools and Techniques Morgan Kaufmann, 2000.
14. D. Hand, H. Mannila and P. Smyth. Principles of Data Mining. Prentice-Hall. 2001
15. Valliappa Lakshmanan, Jordan Tigani, Google BigQuery: The Definitive Guide**:** Data Warehousing, Analytics, and Machine Learning, O'Reilly Media, Inc.", 2019

221ECS002	CLOUD COMPUTING	CATEGORY	L	T	P	CREDIT
		PROGRAM ELECTIVE 1	3	0	0	3

Preamble: Study of cloud computing is an essential to understand the overall concepts of virtualization and virtual machines This course helps to gain expertise in server, network, storage virtualization, deploy practical virtualization solutions, enterprise solutions etc. They will be able to set up a private cloud by understand the security issues in the grid and the cloud environment.

Course Outcomes: After the completion of the course the student will be able to

CO 1	Employ the concepts of storage virtualization, network virtualization and its management. **(Cognitive Knowledge Level: Apply)**
CO 2	Apply the concept of virtualization in the cloud computing. **(Cognitive Knowledge Level: Apply)**
CO 3	Apply domain knowledge in architecture, infrastructure and delivery models of cloud computing in designing and developing cloud applications. **(Cognitive Knowledge Level: Apply)**
CO 4	Develop services using Cloud computing. **(Cognitive Knowledge Level: Apply)**
CO 5	Analyse and choose security models appropriateto the cloud environment. **(Cognitive Knowledge Level: Analyse)**
CO 6	Design, develop and implement cloud based applications. **(Cognitive Knowledge Level: Create)**

Program Outcomes (PO)

Outcomes are the attributes that are to be demonstrated by a graduate after completing the course.

PO1: An ability to independently carry out research/investigation and developmentwork in engineering and allied streams

PO2: An ability to communicate effectively, write and present technical reports on complex engineering activities by interacting with the engineering fraternity and with society at large.

PO3: An ability to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program

PO4: An ability to apply stream knowledge to design or develop solutions for real world problems by following the standards

PO5: An ability to identify, select and apply appropriate techniques, resources and state-of-the-art tool to model, analyse and solve practical engineering problems.

PO6: An ability to engage in life-long learning for the design and development related to the stream related problems taking into consideration sustainability, societal, ethical and environmental aspects

PO7: An ability to develop cognitive load management skills related to project management and finance which focus on Entrepreneurship and Industry relevance.

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
CO 1	✓		✓	✓	✓	✓	
CO 2	✓		✓	✓	✓	✓	
CO 3	✓		✓	✓	✓	✓	
CO 4	✓		✓	✓	✓	✓	
CO 5	✓		✓	✓	✓	✓	
CO 6	✓	✓	✓	✓	✓	✓	✓

Assessment Pattern

Bloom's Category	End Semester Examination
Apply	70%-80%
Analyse	30%-40%
Evaluate	
Create	

Mark distribution

Total Marks	CIE	ESE	ESE Duration
100	40	60	2.5 hours

Continuous Internal Evaluation Pattern:

Evaluation shall only be based on application, analysis or design-based questions (for both internal and end semester examinations).

Continuous Internal Evaluation: 40 marks

i. Preparing a review article based on peer reviewed original publications (minimum 10 publications shall be referred) : 15 marks

ii.Course based task / Seminar/ Data collection and interpretation : 15 marks

iii. Test paper (1 number) : 10 marks

Test paper shall include minimum 80% of the syllabus.
Course based task/test paper questions shall be useful in the testing of knowledge, skills, comprehension, application, analysis, synthesis, evaluation and understanding of the students.

End Semester Examination Pattern:

The end semester examination will be conducted by the respective College.

There will be two parts; Part A and Part B.

Part A will contain 5 numerical/short answer questions with 1 question from each module, having 5 marks for each question. Students should answer all questions. Part B will contain 7 questions (such questions shall be useful in the testing of overall achievement and maturity of the students in a course, through long answer questions relating to theoretical/practical knowledge, derivations, problem solving and quantitative evaluation), with minimum one question from each module of which student should answer any five. Each question can carry 7 marks

Total duration of the examination will be 150 minutes.

Note: The marks obtained for the ESE for an elective course shall not exceed 20% over the average ESE mark % for the core courses. ESE marks awarded to a student for each elective course shall be normalized accordingly.

For example, if the average end semester mark % for a core course is 40, then the maximum eligible mark % for an elective course is 40+20 = 60 %.

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. A project for 2 months requires 1000TB of memory during the development phase. Predict the cloud service that can be used and list the advantages.
2. Illustrate different types of hypervisors with examples. Also enlist the advantages and disadvantages of each.

Course Outcome 2 (CO2):

1. Virtualization can be applied into different levels, "ranging from hardware to application". Comment your opinion with explanation.
2. An American e-commerce web site "Nordstrom" was experiencing a high increase in their customers before New Year. What type of resource provisioning can be done here? Explain.
3. In a virtual environment, guest OS cannot directly access Host machine memory. How can this be achieved.

Course Outcome 3(CO3):

1. How hybrid cloud helps in the growth of your business.
2. Your company runs a virtualized web application server in-house. You decide to make the web applications available over the Internet through a cloud provider. Which method is the quickest way to accomplish this?
3. If 2 teams from US and India are collaboratively working on a project, discuss a means by which they can access data. Explain with 2 examples.
4. Imagine you are conducting Arts Festival of your college. Explain the different steps that you will take to make the event successful using cloud.

Course Outcome 4 (CO4):

1. Write the steps to configure Hadoop Map Reduce environment in Linux for developing a Map Reduce program.
2. Write a word count Map Reduce program in Java.
3. Identify the storage system used by Google Earth software. Explain how to locate a data in such a data store.
4. Identify the cloud service model used in Netflix. Justify your answer.

Course Outcome 5 (CO5):

1. A company XYZ wishes to lease resources in the cloud. List and explain security issues that must be discussed with Technology Analyst to ensure secure cloud usage.
2. Identify the cloud service offered by Gmail & Google drive and explain key features of each service?
3. Why it is harder to establish security in the cloud?

Course Outcome 6 (CO6):

1. Design, develop and implement an efficient cloud based parallel programming model to count distinct place names in kerala.

Model Question Paper

QP CODE:

Reg No: _____

Name: _____ **PAGES:2**

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

FIRST SEMESTER M.TECH DEGREE EXAMINATION, MONTH & YEAR

Course Code: 221ECS002

Course Name: CLOUD COMPUTING

Max. Marks : 60 **Duration: 2.5 Hours**

PART A

Answer All Questions. Each Question Carries 5 Marks

1.	Sketch the core the differences between a traditional computer and a virtual machine.	**(5)**
2.	Explain your understanding about virtualization. What is the role of VMM in virtualization?	**(5)**
3.	Illustrate PaaS model for cloud computing.	**(5)**
4.	Summarize the concept of Map Reduce? Explain the logical data flow of Map Reduce function using suitable example.	**(5)**
5.	illustrate the major security challenges in clouds?	**(5)**

Part B

(Answer any five questions. Each question carries 7 marks)

6.	How Memory virtualization is implemented? Provide necessary examples and diagrams wherever necessary	**(7)**
7.	Investigate the functional modules of Google App Engine?	**(7)**
8.	Sketch the core idea about virtualization. What is the role of VMM in virtualization?	**(7)**
9.	Is it harder to establish security in the cloud? Justify	**(7)**
10.	With a neat diagram explain the Generic Cloud architecture and components.	**(7)**
11.	With neat diagram explain your understanding Security Architecture Design in cloud.	**(7)**
12.	Demonstrate Private Cloud Design using Open Nebula.	**(7)**

Syllabus

Module 1: Virtualization

Basics of Virtual Machines - Process Virtual Machines – System Virtual Machines – Emulation – Interpretation – Binary Translation - Taxonomy of Virtual Machines. Virtualization –Management — Hardware Maximization – Architectures – Virtualization Management – Storage Virtualization – Network Virtualization

Module 2: Virtualization Infrastructure

Comprehensive Analysis – Resource Pool – Testing Environment –Server Virtualization – Virtual Workloads – Provision -Virtual Machines – Desktop Virtualization – Application Virtualization - Implementation levels of virtualization – virtualization structure – virtualization of CPU-Memory and I/O devices – virtual clusters and Resource Management – Virtualization for data centre automation.

Module 3: Cloud Platform Architecture

Understanding cloud computing-Cloud Computing – History of Cloud Computing-Advantages and Disadvantages of Cloud Computing- Cloud deployment models-public-private- hybrid- Categories of cloud computing-Everything as a service-Infrastructure-platform-software- A Generic Cloud Architecture Design – Layered cloud Architectural Development – Virtualization Support and Disaster Recovery – Architectural Design Challenges - Public Cloud Platforms –GAE-AWS – Inter-cloud Resource Management

Module 4: Programming Mode

Introduction to Hadoop Framework – Map Reduce-Input splitting-map and reduce functions-specifying input and output parameters-configuring and running a job –Developing Map Reduce Applications - Design of Hadoop file system –Setting up Hadoop Cluster - Cloud Software Environments –Eucalyptus-Open Nebula-Open Stack-Nimbus

Module 5: Cloud Security

Cloud Infrastructure security- network, host and application level – aspects of data security-provider data and its security-Identity and access management architecture-IAM practices in the cloud-SaaS-PaaS-IaaS availability in the cloud - Key privacy issues in the cloud –Cloud Security and Trust Management

Course Plan

No	Topic	No. of Lectures (**40 Hours**)
1	**Module 1: Virtualization**	**8**
1.1	Basics of Virtual Machines	1
1.2	Process Virtual Machines, System Virtual Machines	1
1.3	Emulation, Interpretation	1
1.4	Binary Translation	1
1.5	Taxonomy of Virtual Machines	1
1.6	Virtualization –Management, Hardware Maximization	1
1.7	Architectures, Virtualization Management	1
1.8	Storage Virtualization, Network Virtualization	1
2	**Module 2: Virtualization Infrastructure**	**8**
2.1	Comprehensive Analysis, Resource Pool	1
2.2	Testing Environment, Server Virtualization	1
2.3	Virtual Workloads	1
2.4	Provision, Virtual Machines	1
2.5	Desktop Virtualization, Application Virtualization	1
2.6	Implementation levels of virtualization, virtualization structure, virtualization of CPU	1
2.7	Memory and I/O devices	1
2.8	virtual clusters and Resource Management, Virtualization for data centre automation	1
3	**Module 3: Cloud Platform Architecture**	**9**
3.1	Understanding cloud computing-Cloud Computing – History of Cloud Computing- Advantages and Disadvantages of Cloud Computing	1
3.2	Cloud deployment models, Public-private- hybrid, Categories of cloud computing	1
3.3	Everything as a service, Infrastructure	1
3.4	Platform, Software	1
3.5	A Generic Cloud Architecture Design, Layered cloud Architectural	1

	Development	
3.6	Virtualization Support and Disaster Recovery, Architectural Design Challenges	1
3.7	Public Cloud Platforms	1
3.8	GAE, AWS	1
3.9	Inter-cloud Resource Management	1
4	**Module 4: Programming Mode**	**8**
4.1	Introduction to Hadoop Framework, Map Reduce	1
4.2	Input splitting	1
4.3	map and reduce functions, specifying input and output parameters	1
4.4	configuring and running a job, Developing Map Reduce Applications	1
4.5	Design of Hadoop file system, Setting up Hadoop Cluster	1
4.6	Cloud Software Environments, Eucalyptus	1
4.7	Open Nebula, Open Stack	1
4.8	Nimbus	1
5	**Module 5: Cloud Security**	**7**
5.1	Cloud Infrastructure security	1
5.2	network, host and application level	1
5.3	aspects of data security, provider data and its security	1
5.4	Identity and access management architecture	1
5.5	IAM practices in the cloud	1
5.6	SaaS, PaaS, IaaS availability in the cloud	1
5.7	Key privacy issues in the cloud, Cloud Security and Trust Management	1

References

1. Greg Schulz, "Cloud and Virtual Data Storage Networking", Auerbach Publications [ISBN: 978-1439851739], 2011.
2. Michael Miller, Cloud Computing: Web-Based Applications That Change the Way You Work and Collaborate Online, Que Publishing, August 2008.
3. GauthamShroff, "Enterprise Cloud Computing: Technology, Architecture, Applications", Cambridge press, 2010.
4. EMC, "Information Storage and Management" Wiley; 2 edition [ISBN: 978-0470294215],2012.

5. Kai Hwang , Geoffrey C Fox, Jack J Dongarra : “Distributed and Cloud Computing – From Parallel Processing to the Internet of Things” , Morgan Kaufmann Publishers – 2012.

221ECS003	WEB SERVICES	CATEGORY	L	T	P	CREDIT
		PROGRAM ELECTIVE 1	3	0	0	3

Preamble: This course provides an understanding of the purpose of using web services in web development. The topics covered in this course are the basic concepts and types of web services, server side and client-side web services and an introduction to development of dynamic web pages. The learners will be able to develop a web based service application.

Course Outcomes: After the completion of the course the student will be able to

CO 1	Illustrate the need of web services in developing applications. **(Cognitive Knowledge Level: Understand)**
CO 2	Make use of Server-side and Client-side RESTful web services. **(Cognitive Knowledge Level: Analyze)**
CO 3	Analyze how web services can be published in standalone web servers. **(Cognitive Knowledge Level: Analyze)**
CO 4	Employ techniques on creating dynamic web pages. **(Cognitive Knowledge Level: Apply)**
CO 5	Utilize emerging technologies in web services. **(Cognitive Knowledge Level: Apply)**
CO 6	Design, Develop, Implement and Present innovative ideas on modern web services concepts and techniques. **(Cognitive Knowledge Level: Create)**

Program Outcomes (PO)

Outcomes are the attributes that are to be demonstrated by a graduate after completing the course.

PO1: An ability to independently carry out research/investigation and development work in engineering and allied streams

PO2: An ability to communicate effectively, write and present technical reports on complex engineering activities by interacting with the engineering fraternity and with society at large.

PO3: An ability to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program

PO4: An ability to apply stream knowledge to design or develop solutions for real world problems by following the standards

PO5: An ability to identify, select and apply appropriate techniques, resources and state-of-the-art tool to model, analyse and solve practical engineering problems.

PO6: An ability to engage in life-long learning for the design and development related to the stream related problems taking into consideration sustainability, societal, ethical and environmental aspects

PO7: An ability to develop cognitive load management skills related to project management and finance which focus on Entrepreneurship and Industry relevance.

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
CO 1	✓		✓	✓		✓	
CO 2	✓		✓	✓		✓	
CO 3	✓		✓	✓		✓	
CO 4	✓		✓	✓	✓	✓	✓
CO 5	✓		✓	✓	✓	✓	
CO 6	✓	✓	✓	✓	✓	✓	✓

Assessment Pattern

Bloom's Category	End Semester Examination
Apply	70%-80%
Analyze	30%-40%
Evaluate	
Create	

Mark distribution

Total Marks	CIE	ESE	ESE Duration
100	40	60	2.5 hours

Continuous Internal Evaluation Pattern:

Evaluation shall only be based on application, analysis or design based questions (for both internal and end semester examinations).

Continuous Internal Evaluation: 40 marks

i. Preparing a review article based on peer reviewed original publications (minimum 10 publications shall be referred) : 15 marks

ii. Course based task / Seminar/ Data collection and interpretation : 15 marks

iii. Test paper (1 number) : 10 marks

Test paper shall include minimum 80% of the syllabus.

Course based task/test paper questions shall be useful in the testing of knowledge, skills, comprehension, application, analysis, synthesis, evaluation and understanding of the students.

End Semester Examination Pattern:

The end semester examination will be conducted by the respective College.

There will be two parts; Part A and Part B.

Part A will contain 5 numerical/short answer questions with 1 question from each module, having 5 marks for each question. Students should answer all questions. Part B will contain 7 questions (such questions shall be useful in the testing of overall achievement and maturity of the students in a course, through long answer questions relating to theoretical/practical knowledge, derivations, problem solving and quantitative evaluation), with minimum one question from each module of which student should answer any five. Each question can carry 7 marks

Total duration of the examination will be 150 minutes.

Note: The marks obtained for the ESE for an elective course shall not exceed 20% over the average ESE mark % for the core courses. ESE marks awarded to a student for each elective course shall be normalized accordingly.

For example if the average end semester mark % for a core course is 40, then the maximum eligible mark % for an elective course is 40+20 = 60 %.

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Illustrate how HTTP requests and responses are handled.
2. Discuss the different types of Web services
3. Identify the commonly used HTTP methods in REST Architecture
4. Explain the advantages of Service Oriented Architecture

Course Outcome 2 (CO2):

1. Explain RESTful web services.
2. Examine the purpose of Client-Side and Server side API
3. Elaborate on the advanced features of Client API.

Course Outcome 3(CO3):

1. Explain the need for JSON
2. Illustrate the steps for publishing JAX-RS Resources to Apache Tomcat.

Course Outcome 4 (CO4):

1. How can we interpret the architecture of SOAP based service?
2. Demonstrate how the WSDL document, can be put to good use in writing a Java client against the RandService.
3. Implement dynamic content on web page using Web method in form of JSON object.

Course Outcome 5 (CO5):

1. Demonstrate dynamic webpages using React.js and Angular.js
2. Use ReactJS to build a simple search filter functionality to display a filtered list based on the search query entered by the user.

Course Outcome 6 (CO6):

1. Develop a UI based application and create client/server side web services to perform relevant tasks related to project requirements.

Model Question Paper

QP CODE:

Reg No: _____

Name: _____ **PAGES : 2**

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

FIRST SEMESTER M.TECH DEGREE EXAMINATION, MONTH & YEAR

Course Code: 221ECS003

Course Name: WEB SERVICES

Max. Marks : 60 **Duration: 2.5 Hours**

PART A

Answer All Questions. Each Question Carries 5 Marks

1.	Examine the possible reasons for the choice of Web services over Web applications.	**(5)**
2.	Why are HTTP servlets a convenient way for implementing RESTful web services?	**(5)**
3.	Explain how a basic client request can be created using the Client API	**(5)**
4.	Describe the architecture of a SOAP based Web Service.	**(5)**
5.	Discuss the facts how React is different from Angular.	**(5)**

Part B

(Answer any five questions. Each question carries 7 marks)

6.	How are SOAP and RESTful Web services architecturally different from each other?	**(7)**
7.	Illustrate the process of publishing JAX-RS resources with Tomcat.	**(7)**
8.	'JSONP brings an event-driven API to client-side processing'- Justify the statement using examples.	**(7)**
9.	Explain how a documents client service *REST Client* can be created from the DOCS DWADL.	**(7)**
10.	Describe the structure of a WSDL document with example.	**(7)**
11.	Analyse the purpose of render in React. How would you prevent unnecessary component re-render in ReactJS?	**(7)**

12. Demonstrate with examples, the two approaches that AngularJS takes, to build forms. **(7)**

Syllabus

Module 1: Introduction to Web Services

Web Services Standards Organizations, Service oriented architecture, Advantages of web services over distributed object architecture, SOAP-based web services, RESTful web services.

Review of HTTP requests and responses- HTTP as an API, A RESTful example, Use of Servlets for RESTful Web Services.

Module 2: RESTful Web Services: The Service Side

A RESTful service as an HttpServlet, Implementation details.

A RESTful Web Service as a JAX-RS Resource- JAX-RS Web Service Using Jersey, Publishing JAX-RS Resources with a Java Application, Publishing JAX-RS Resources with Tomcat, JAX-RS Generation of XML and JSON Responses, Porting the Predictions Web Service to JAX-RS.

A RESTful Web Service as Restlet Resources.

GraphQL- Introduction to GraphQL, GraphQL Architecture, Basic Queries.

Module 3: RESTful Web Services: The Client Side- A Perl Client Against a Java RESTful Web Service

RESTful Clients and WADL Documents- The JAX-RS Client API, JSON for JavaScript Clients- JSONP and Web Services.

Module 4: SOAP-Based Web Services- Introduction and Evolution of SOAP, Architecture of a typical SOAP-based service, Publishing a SOAP-Based Service with a Standalone Web Server

RandService- JavaClient Against the RandService, C# Client Against the RandService, A Perl Client Against the RandService. WSDL – WSDL document structure.

Module 5: Introduction to React.js, Node.js and Angular.js

Introduction to React and Node-Basic Concepts and Applications, Rendering Elements and Components, Comparison and Purpose of Node.js and React.js, Angular JS Basics-Modules, Creating Components, Directives, Filters, Angular Forms-Services, Single page application and Multipage application, Use case of a real-time single page chat application.

Course Plan

No	Topic	No. of Lectures (**40 Hours**)
1	**Module 1: Introduction to Web Services**	**8**
1.1	Introduction to web services- Web Services Standards Organizations, Service oriented architecture	1
1.2	Advantages of web services over distributed object architecture	1
1.3	SOAP-based web services	1
1.4	RESTful web services	1
1.5	Review of HTTP requests and responses	1
1.6	HTTP as an API	1
1.7	A RESTful example	1
1.8	Use of Servlets for RESTful Web Services	1
2	**Module 2: RESTful Web Services: The Service Side**	**8**
2.1	A RESTful service as an HttpServlet, Implementation details	1
2.2	A RESTful Web Service as a JAX-RS Resource	1
2.3	JAX-RS Web Service Using Jersey	1
2.4	Publishing JAX-RS Resources with a Java Application	1
2.5	Publishing JAX-RS Resources with Tomcat	1
2.6	JAX-RS Generation of XML and JSON Responses	1
2.7	Porting the Predictions Web Service to JAX-RS	1
2.8	GraphQL- Introduction to GraphQL, GraphQL Architecture, Basic Queries	1
3	**Module 3: RESTful Web Services: The Client Side**	**8**
3.1	A Perl Client Against a Java RESTful Web Service (Lecture 1)	1
3.2	A Perl Client Against a Java RESTful Web Service (Lecture 2)	1
3.3	RESTful Clients and WADL Documents (Lecture 1)	1
3.4	RESTful Clients and WADL Documents (Lecture 2)	1
3.5	The JAX-RS Client API	1
3.6	JSON for JavaScript Clients	1
3.7	JSONP and Web Services (Lecture 1)	1

3.8	JSONP and Web Services (Lecture 2)	1
4	**Module 4: SOAP-Based Web Services**	**8**
4.1	Introduction and Evolution of SOAP	1
4.2	Architecture of a typical SOAP-based service	1
4.3	Publishing a SOAP-Based Service with a Standalone Web Server (Lecture 1)	1
4.4	Publishing a SOAP-Based Service with a Standalone Web Server (Lecture 2)	1
4.5	RandService- JavaClient Against the RandService	1
4.6	C# Client Against the RandService	1
4.7	A Perl Client Against the RandService	1
4.8	WSDL – WSDL document structure	1
5	**Module 5: Introduction to React.js, Node.js and Angular.js**	**8**
5.1	Introduction to React and Node, Basic Concepts and Applications	1
5.2	Rendering Elements and Components	1
5.3	Comparison and Purpose of Node.js and React.js	1
5.4	Angular JS Basics-Modules	1
5.5	Creating Components, Directives,Filters	1
5.6	Angular Forms-Services	1
5.7	Single page application and Multipage application	1
5.8	Use case of a real-time single page chat application.	1

References

1. Martin Kalin, Java Web Services: Up and Running, Second Edition, O'Reilly, 2013

2. Robin Wieruch, The Road to Learn React, https://www.roadtoreact.com, 2022 Edition

3. Andrew Grantt, Beginning Angular JS, Apress, 2014

4. Vipul A M and Prathamesh Sonpatki, ReactJS by Example - Building Modern Web Applications with React, PACKT Publishing, 2016

5. Node.js Web Development: Server-side web development made easy with Node 14 using practical examples, 5th Edition, PACKT Publishing, 2020

6. Alex Banks, Eve Porcello, Learning GraphQL, O'Reilly Media, 2018

221ECS004	COMPUTATIONAL INTELLIGENCE	CATEGORY	L	T	P	CREDIT
		PROGRAM ELECTIVE 1	3	0	0	3

Preamble: The aim of this course is to provide the students with the knowledge and skills required to design and implement effective and efficient Computational Intelligence solutions to problems for which a direct solution is impractical or unknown. This course covers concepts of fuzzy logic, genetic algorithms, and swarm optimization techniques. The learners will be able to provide Fuzzy and AI –based solutions to real world problems.

Course Outcomes: After the completion of the course the student will be able to

CO 1	Apply fuzzy logic to handle uncertainty and solve engineering problems. **(Cognitive Knowledge Level : Apply)**
CO 2	Apply Fuzzy Logic Inference methods in building intelligent machines. **(Cognitive Knowledge Level : Apply)**
CO 3	Design genetic algorithms for optimized solutions in engineering problems. **(Cognitive Knowledge Level : Analyze)**
CO 4	Analyze the problem scenarios and apply Ant colony system to solve real optimization problems. **(Cognitive Knowledge Level : Analyze)**
CO 5	Apply PSO algorithm to solve real world problems. **(Cognitive Knowledge Level : Apply)**
CO6	Design, develop and implement solutions based on computational intelligence concepts and techniques. **(Cognitive Knowledge Level : Create)**

Program Outcomes (PO)

Outcomes are the attributes that are to be demonstrated by a graduate after completing the course.

PO1: An ability to independently carry out research/investigation and developmentwork in engineering and allied streams

PO2: An ability to communicate effectively, write and present technical reports on complex engineering activities by interacting with the engineering fraternity and with society at large.

PO3: An ability to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program

PO4: An ability to apply stream knowledge to design or develop solutions for real world problems by following the standards

PO5: An ability to identify, select and apply appropriate techniques, resources and state-of-the-art tool to model, analyse and solve practical engineering problems.

PO6: An ability to engage in life-long learning for the design and development related to the stream related problems taking into consideration sustainability, societal, ethical and environmental aspects

PO7: An ability to develop cognitive load management skills related to project management and finance which focus on Entrepreneurship and Industry relevance.

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
CO 1				✓		✓	
CO 2	✓		✓	✓	✓	✓	
CO 3	✓		✓	✓	✓	✓	
CO 4	✓		✓	✓	✓	✓	
CO 5	✓		✓	✓	✓	✓	
CO 6	✓	✓	✓	✓	✓	✓	✓

Assessment Pattern

Bloom's Category	End Semester Examination
Apply	70%-80%
Analyze	30%-40%
Evaluate	
Create	

Mark distribution

Total Marks	CIE	ESE	ESE Duration
100	40	60	2.5 hours

Continuous Internal Evaluation Pattern:

Evaluation shall only be based on application, analysis or design based questions (for both internal and end semester examinations).

Continuous Internal Evaluation: 40 marks

i. Preparing a review article based on peer reviewed original publications (minimum 10 publications shall be referred) : 15 marks

ii. Course based task / Seminar/ Data collection and interpretation : 15 marks

iii. Test paper (1 number) : 10 marks

Test paper shall include minimum 80% of the syllabus.

Course based task/test paper questions shall be useful in the testing of knowledge, skills, comprehension, application, analysis, synthesis, evaluation and understanding of the students.

End Semester Examination Pattern:

The end semester examination will be conducted by the respective College.

There will be two parts; Part A and Part B.

Part A will contain 5 numerical/short answer questions with 1 question from each module, having 5 marks for each question. Students should answer all questions. Part B will contain 7 questions (such questions shall be useful in the testing of overall achievement and maturity of the students in a course, through long answer questions relating to theoretical/practical knowledge, derivations, problem solving and quantitative evaluation), with minimum one question from each module of which student should answer any five. Each question can carry 7 marks

Total duration of the examination will be 150 minutes.

Note: The marks obtained for the ESE for an elective course shall not exceed 20% over the average ESE mark % for the core courses. ESE marks awarded to a student for each elective course shall be normalized accordingly.

For example if the average end semester mark % for a core course is 40, then the maximum eligible mark % for an elective course is 40+20 = 60 %.

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Let V = {A, B, C, D} be the set of four kinds of vitamins, F = {f_1, f_2, f_3} be three kinds of fruits containing the vitamins to various extents, and D = {d_1, d_2, d_3} be the set of three diseases that are caused by deficiency of these vitamins. Vitamin contents of the fruits are expressed with the help of the fuzzy relation R over F x V, and the extent of which diseases are caused the deficiency of these vitamins is given by the fuzzy relation S over V x D. Relations R and S are given below

$$R = [0.5\ 0.2 \quad 0.2\ 0.7 \quad 0.4\ 0.4 \quad 0.1\ 0.1\ 0.4\ 0.3\ 0.8\ 0.1\ ]S$$
$$= [0.3\ 0.5\ 0.1\ 0.8\ \ 0.7\ 0.4\ \ 0.9\ 0.1\ 0.5\ 0.5\ \ 0.2\ 0.3\ \ ]$$

Find the correlation between the amount of certain fruit that should be taken while suffering from a disease.

Course Outcome 2 (CO2):

1. In mechanics, the energy of a moving body is called kinetic energy. Suppose we model mass and velocity as inputs to a moving body and energy as output. Observe the system for a while and the following rule is deduced.

   IF x is small and y is high

   THEN z is medium

   The graphical representation of rule is given below. Let the inputs given are 0.35kg and 55m/s. What will the output using Mamdani inference? Any defuzzification method can be used to obtain the crisp single output.

Course Outcome 3(CO3):

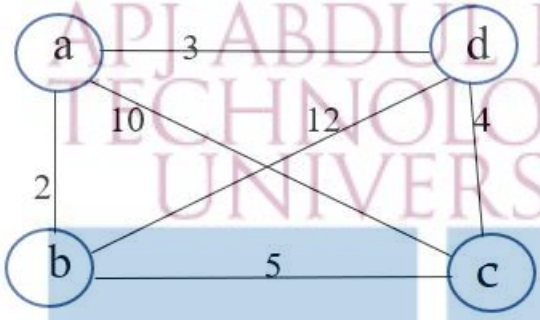
1. Describe how Roulette wheel is used for selection. Draw the Roulette wheel for six chromosomes corresponding to the table given below.

Chromosome #	***Fitness***
1	10
2	5
3	25
4	15
5	30
6	20

Course Outcome 4 (CO4):

1. Consider an Ant Colony System based on Ant Quantity model for solving the following Travelling Salesman Problem. Compute the pheromone content at each of the edges after 4 steps(1 iteration). Assume pheromone decay factor ρ=0.1, Q = 120. Assume initial pheromone of 50 units at each of the edges and that three ants k1,k2 and k3 follow the paths given below in the first iteration.

   k1= a b c d a; k2=a c b d a; k3=a d c b a



2. Six jobs go first on machine A, then on machine B, and finally on machine C. The order of the completion of the jobs in the three machines is given in Table

Jobs	Processing time(hr)		
	Machine A	Machine B	Machine C
1	8	3	8
2	3	4	7
3	7	5	6
4	2	2	9
5	5	1	10
6	1	6	9

Find the sequence of jobs that minimizes the time required to complete the jobs using the ACS model.

Course Outcome 5 (CO5):

1. Consider a particle swarm optimization system composed of three particles and maximum velocity 10. Assume that both the random numbers r1 and r2 used for computing the movement of the particle towards the individual best position and social best position are 0.5. Also assume that the space of solutions is the two dimensional real valued space and the current state of swarm is as follows:

Position of particles: x1 = (4,4); x2 = (8,3); x3 = (6,7)

Individual best positions : $x1^* = (4,4)$; $x2^* = (7,3)$; $x3^* = (5,6)$

Velocities: v1 = (2,2); v2 = (3,3); v3 = (4,4)

What would be the next position of each particle after one iteration of the PSO algorithm if the inertia parameter ω that is used along with current velocity update formula is 0.8 ?

Course Outcome 6 (CO6):

1. Implement travelling salesman problem using appropriate optimization technique.

Model Question Paper

QP CODE:

Reg No: _____

Name: _____ **PAGES: 5**

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

FIRST SEMESTER M. TECH DEGREE EXAMINATION, MONTH & YEAR

Course Code: 221ECS004

Course Name: Computational Intelligence

Max. Marks : 60 **Duration: 2.5 Hours**

PART A

Answer All Questions. Each Question Carries 5 Marks

1. Consider the set of Colours A= {Blue, Red, Orange, Yellow, Green}, Attributes B = {Bright, Warmth, Dullness}, Feelings C= {Unpleasant, happiness, Angry}. Given R and S where R is the relationship between colours and their attributes and S is the relationship between colour attributes and feelings created. Find the relationship Q between colours and feelings created **(5)**

R	Bright	Warmth	Dullness
Blue	0.8	0.6	0.4
Red	0.8	0.8	0.2
Orange	0.5	0.7	0.2
Yellow	0.3	0.6	0.5
Green	0.8	0.6	0.4

S	Unpleasant	Happiness	Angry
Bright	0.2	0.8	0.6
Warmth	0.4	0.7	0.8
Dullness	0.8	0.3	0.6

2. Develop a membership function for "Tall". Based on that devise membership function for "Very Tall". Explain how it is done **(5)**

3. Mention the importance of objective (fitness) function in genetic algorithm **(5)**

4. Describe how pheromone is updated. What is elitist / elastic ants ? Are they useful in this scenario? **(5)**

5. What is the significance of pbest and gbest particles in solving problems with particle swarm optimization? **(5)**

Part B

(Answer any five questions. Each question carries 7 marks)

6. (a) Consider the set of fruits F = {Apple , Orange, Lemon, Strawberry, Pineapple}. **(3)**

Let sweet fruits B= $\{\frac{0.8}{Apple}+\frac{0.6}{Orange}+\frac{0.2}{Lemon}+\frac{0.4}{Strawberry}+\frac{0.7}{Pineapple}\}$ and

Sour Fruits F= $\{\frac{0.6}{Apple}+\frac{08}{Orange}+\frac{0.9}{Lemon}+\frac{0.7}{Strawberry}+\frac{0.5}{Pineapple}\}$

Find Fruits that are Sweet or Sour, Sweet but not Sour, Sweet and Sour

(b) Consider two fuzzy Sets given by **(4)**

$$P=\left\{\frac{0.9}{short}+\frac{0.3}{medium}+\frac{0.5}{tall}\right\}$$

$$Q=\left\{\frac{0.7}{positive}+\frac{0.4}{zero}+\frac{0.8}{negative}\right\}$$

Find the fuzzy relation for the Cartesian product of P and Q i.e, R=P x Q .

Introduce a fuzzy set T given by

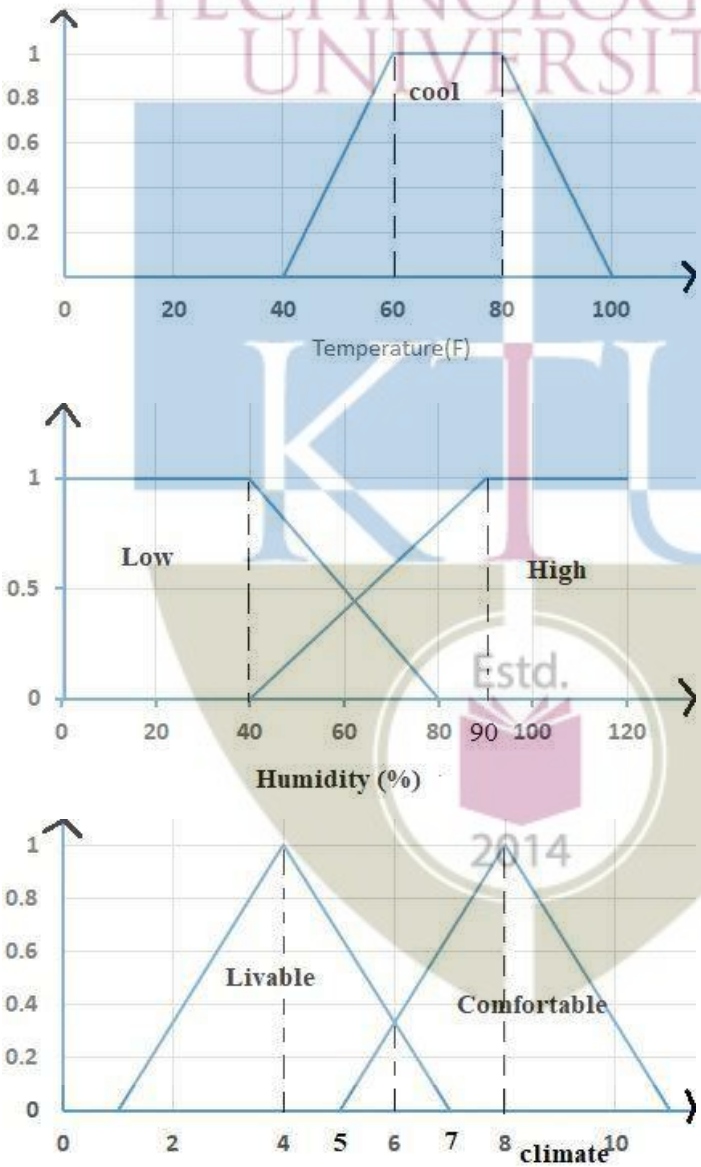
$$T=\left\{\frac{0.9}{short}+\frac{0.3}{medium}+\frac{0.6}{tall}\right\}$$

and Find T o R using max-min composition

7. Consider a Fuzzy Inference System for checking climate comfortability of human beings for long time living. The system accepts two inputs – temperature and humidity. The rules and membership functions of FIS is given below. Using Mamdani inference and center of sum, calculate output when the temperature is 50Fahrenheit and humidity is 50%. **(7)**

Rule 1: IF temperature is cool and humidity is low, THEN climate is comfortable.

Rule 2: IF temperature is cool and humidity is high, THEN climate is livable



The fuzzy sets "Easy Question Paper" and their corresponding "Student Performance" are given below

$$\text{Easy\_QP} = \left\{ \frac{0.8}{1} + \frac{0.2}{2} + \frac{0.6}{3} + \frac{0.7}{4} \right\}$$

$$\text{Stud\_Perf} = \left\{ \frac{0.3}{a} + \frac{0.4}{b} + \frac{0.8}{c} + \frac{0.9}{d} \frac{0.8}{1} + \frac{0.2}{2} + \frac{0.6}{3} + \frac{0.8}{4} + \frac{0.7}{5} \right\}$$

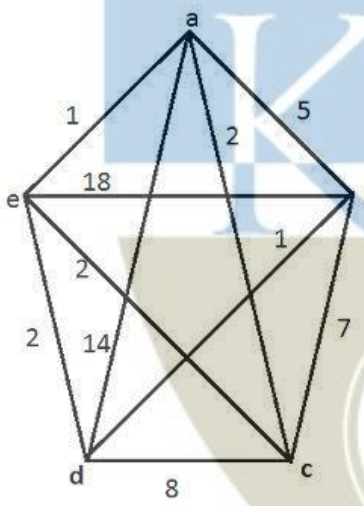
Find the performance of students c and d for the question paper "Somewhat Easy"

$$\text{Somewhat\_Easy} = \left\{ \frac{0.7}{1} + \frac{0.3}{2} + \frac{0.5}{3} + \frac{0.6}{4} \right\}$$

8. Explain any procedure to map a solution to the corresponding chromosome and vice versa in genetic algorithms. Also illustrate it with an example **(7)**

9. Describe two methods used to select individuals from a population for the mating pool in Genetic Algorithms **(7)**

10. (a) Consider the TSP with the following edge costs. Given the evaporation factor $\rho = 0.02$ and initial pheromone at all edges $T_{ij}=100$ **(1)**



What is the cost of best tour?

(b) Using the equation $T_{ij}(t+1)=(1-\rho)T_{ij}(t) + \Delta T_{ij}(t,t+1)$, compute the $T_{ij}$of the edge<a,c> when 10 ants uses the edges <a, c>, using the following models: **(6)**

i. Ant Density Model (Constant Q=10)

ii. Ant Quantity Model(Constant Q=100)

where Q is the constant related to the pheromone updation.

11. Describe Ant Colony System. What are the different types of Ant systems? **(7)**

12. Consider a particle swarm optimization system composed of three particles and maximum velocity 10. Assume that both the random numbers r1 and r2 used for computing the movement of the particle towards the individual best position and social best position are 0.5. Also assume that the space of solutions is the two-dimensional real valued space and the current state of swarm is as follows: **(7)**

Position of particles: x1 = (4,4); x2 = (8,3); x3 = (6,7)

Individual best positions: $x1^* = (4,4)$; $x2^* = (7,3)$; $x3^* = (5,6)$

Velocities: v1 = (2,2); v2 = (3,3); v3 = (4,4)

What would be the next position of each particle after one iteration of the PSO algorithm if the inertia parameter ω that is used along with current velocity update formula is 0.8 ?

Syllabus

Module 1: Fuzzy Logic

Crisp sets vs fuzzy sets- Operations and properties of Fuzzy sets. Membership functions - Linguistic variables. Operations on fuzzy sets- Fuzzy laws- Operations on fuzzy relations, Fuzzy composition- Max- min, Max – product. Alpha-cut representation.

Module 2: Fuzzy Systems

Fuzzy Reasoning – GMP and GMT. Fuzzy Inference System: Defuzzification methods - Fuzzy Controllers -Mamdani FIS, Larsen Model

Module 3: Genetic Algorithms

Introduction to Genetic Algorithms – Theoretical foundation - GA encoding, decoding - GA operations – Elitism – GA parameters – Convergence. Multi-objective Genetic Algorithm – Pareto Ranking.

Module 4: Ant Colony Systems

Swarm intelligent systems - Background Ant colony systems – Biological systems- Development of the ant colony system- - Working - Pheromone updating- Types of ant systems- ACO algorithms for TSP

Module 5: Particle Swarm Optimization

Basic Model - Global Best PSO- Local Best PSO- Comparison of 'gbest' to 'lbest'- PSO Algorithm Parameters- Problem Formulation of PSO algorithm- Working. Rate of convergence improvements -Velocity clamping- Inertia weight- Constriction Coefficient- Boundary Conditions- Guaranteed Convergence PSO- Initialization, Stopping Criteria, Iteration Terms and Function Evaluation.

Course Plan

No	Topic	No. of Lectures (40)
1	**Module 1: Fuzzy Logic**	**9**
1.1	Crisp sets vs fuzzy sets, Operations and properties of Fuzzy sets	1
1.2	Membership functions	1
1.3	Linguistic Variables	1
1.4	Operations on fuzzy sets	1
1.5	Fuzzy laws	1
1.6	Operations on fuzzy relations	1
1.7	Fuzzy Composition- Max- min	1
1.8	Fuzzy Composition – Max- Product	1
1.9	Alpha-cut representation	1
2	**Module 2: Fuzzy Systems**	**7**
2.1	Fuzzy Reasoning – GMP	1
2.2	Fuzzy Reasoning –GMT	1
2.3	Fuzzy Inference System	1
2.4	Defuzzification methods	1
2.5	Fuzzy Controllers	1
2.6	Mamdani Model	1
2.7	Larsen Model	1
3	**Module 3: Genetic Algorithms**	**7**
3.1	Introduction to Genetic algorithm	1
3.2	Theoretical foundation	1
3.3	GA encoding - decoding	1
3.4	GA operations	1
3.5	Elitism, GA parameters, Convergence of GA	1
3.6	Multi – objective Genetic Algorithm	1
3.7	Pareto Ranking	1
4	**Module 4: Ant Colony Systems**	**8**
4.1	Swarm intelligent systems	1

4.2	Background	1
4.3	Ant colony systems – biological systems	1
4.4	Development of the ant colony system	1
4.5	Working	1
4.6	Pheromone updating	1
4.7	Types of ant systems	1
4.8	ACO algorithms for TSP	1
5	**Module 5: Particle Swarm Optimization**	**9**
5.1	Basic Model	1
5.2	Global Best PSO	1
5.3	Local Best PSO, Comparison of 'gbest' to 'lbest'	1
5.4	PSO Algorithm Parameters	1
5.5	Problem Formulation	1
5.6	Working	1
5.7	Rate of convergence improvements – velocity clamping	1
5.8	Inertia-weight - Constriction Coefficient- Boundary Conditions	1
5.9	Initialization, Stopping Criteria, Iteration Terms and Function Evaluation	1

References

1. Samir Roy, Udit Chakraborty, Introduction to Soft Computing Neuro- Fuzzy Genetic Algorithms, Pearson, 2013
2. N.P. Padhy, Artificial Intelligence and Intelligent systems, Oxford Press, New Delhi, 2005.
3. Xin-She Yang School of Science and Technology, Middlesex University London, Nature-Inspired Optimization Algorithms, Elsevier, First edition, 2014
4. Satyobroto Talukder, Blekinge Institute of Technology, Mathematical Modelling and Applications of Particle Swarm Optimization, February 2011
5. Mitchell Melanie, An Introduction to Genetic Algorithm, Prentice Hall,1998
6. Andries Engelbrecht, Computational Intelligence: An Introduction, Wiley, 2007
7. Marco Dorigo and Thomas Stutzle, "Ant Colony optimization", Prentice Hall of India, New Delhi 2005

221ECS005	AUTOMATED VERIFICATION	CATEGORY	L	T	P	CREDIT
		PROGRAM ELECTIVE 1	3	0	0	3

Preamble: The course presents an algorithmic approach to the development of formal verification systems. It concentrates on decision procedures for decidable first-order theories that are useful in the context of automated verification and reasoning, theorem proving, compiler optimization, and so forth. Since the ability of these techniques to cope with problems arising in industry depends critically on decision procedures, this is a vibrant and prospering research subject for many researchers around the world, both in academia and in industry.

Course Outcomes: After the completion of the course the student will be able to

CO 1	Use the model-theoretic and proof-theoretic approaches towards formal reasoning. (**Cognitive Knowledge Level: Apply**)
CO 2	Demonstrate how decision procedures can be developed for propositional logic using SAT solvers and Binary Decision Diagrams. (**Cognitive Knowledge Level: Apply**)
CO 3	Develop methods to prove the validity and satisfiability of formulas using Equality Logic and Uninterpreted Functions. (**Cognitive Knowledge Level: Apply**)
CO 4	Illustrate decision procedures using linear arithmetic (**Cognitive Knowledge Level: Analyze**)
CO 5	Design, develop and implement solutions based on the concepts of automated verification. (**Cognitive Knowledge Level: Create**)

Program Outcomes (PO)

Outcomes are the attributes that are to be demonstrated by a graduate after completing the course.

PO1: An ability to independently carry out research/investigation and development work in engineering and allied streams

PO2: An ability to communicate effectively, write and present technical reports on complex engineering activities by interacting with the engineering fraternity and with society at large.

PO3: An ability to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program

PO4: An ability to apply stream knowledge to design or develop solutions for real world problems by following the standards

PO5: An ability to identify, select and apply appropriate techniques, resources and state-of-the-art tool to model, analyse and solve practical engineering problems.

PO6: An ability to engage in life-long learning for the design and development related to the stream related problems taking into consideration sustainability, societal, ethical and environmental aspects

PO7: An ability to develop cognitive load management skills related to project management and finance which focus on Entrepreneurship and Industry relevance.

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
CO 1	✓		✓	✓		✓	
CO 2	✓		✓	✓		✓	
CO 3	✓		✓	✓		✓	
CO 4	✓		✓	✓		✓	
CO 5	✓	✓	✓	✓	✓	✓	✓

Assessment Pattern

Bloom's Category	End Semester Examination
Apply	70%-80%
Analyze	30%-40%
Evaluate	
Create	

Mark distribution

Total Marks	CIE	ESE	ESE Duration
100	40	60	2.5 hours

Continuous Internal Evaluation Pattern:

Evaluation shall only be based on application, analysis or design-based questions (for both internal and end semester examinations).

Continuous Internal Evaluation: 40 marks

i. Preparing a review article based on peer reviewed original publications (minimum 10 publications shall be referred) : 15 marks

ii. Course based task / Seminar/ Data collection and interpretation : 15 marks

iii. Test paper (1 number) : 10 marks

Test paper shall include minimum 80% of the syllabus.
Course based task/test paper questions shall be useful in the testing of knowledge, skills, comprehension, application, analysis, synthesis, evaluation and understanding of the students.

End Semester Examination Pattern:

The end semester examination will be conducted by the respective College.

There will be two parts; Part A and Part B.

Part A will contain 5 numerical/short answer questions with 1 question from each module, having 5 marks for each question. Students should answer all questions. Part B will contain 7 questions (such questions shall be useful in the testing of overall achievement and maturity of the students in a course, through long answer questions relating to theoretical/practical knowledge, derivations, problem solving and quantitative evaluation), with minimum one question from each module of which student should answer any five. Each question can carry 7 marks

Total duration of the examination will be 150 minutes.

Note: The marks obtained for the ESE for an elective course shall not exceed 20% over the average ESE mark % for the core courses. ESE marks awarded to a student for each elective course shall be normalized accordingly.

For example, if the average end semester mark % for a core course is 40, then the maximum eligible mark % for an elective course is 40+20 = 60 %.

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Using Tseitin's encoding, transform the following formula to Conjunctive Normal Form (CNF).

$$\emptyset := \neg(x_1 \wedge (x_2 \vee \ldots \vee x_n))$$

2. Let T_1 and T_2 be two theories whose satisfiability problem is decidable and in the same complexity class. Is the satisfiability problem of a T_1 formula reducible to a satisfiability problem of a T_2 formula? Why?

Course Outcome 2 (CO2):

1. Construct the Binary Decision Diagram (BDD) for $\neg(x_1 \vee (x_2 \wedge \neg x_3))$ with the variable order x_1, x_2, x_3 starting from a decision tree.
2. Show a formulation in propositional logic of the following problem: given a directed graph, does it contain a Hamiltonian cycle?

Course Outcome 3(CO3):

1. Given the formula $F(F(x_1)) \neq F(x_1) \wedge F(F(x_1)) \neq F(x_2) \wedge x_2 = F(x_1)$, reduce its validity problem to a validity problem of an equality logic formula through Ackermann's reduction and Bryant's reduction.
2. Prove the following Lemma.

Lemma: If a domain D is adequate for $\emptyset(e)$and $e' \subseteq e$, then D is adequate for $\emptyset(e')$.

Course Outcome 4 (CO4):

1. Find the worst case run time of the general simplex algorithm if applied to a conjunction of difference logic constraints.
2. Prove that the feasibility problem for integer linear programming is NP-hard.

Course Outcome 5 (CO5):

1. Develop a SAT solver that verifies a compilation process with Translation Validation.

Model Question paper

First Semester M. Tech. Degree Examination, Month, Year

221ECS005 – Automated Verification

Time: 2.5 Hours **Max. Marks: 60**

Part A

(Answer all questions. Each question carries 5 marks) 5x5 = 25 Marks

1. Use Tseitin's encoding to convert the formula $x_1 \Rightarrow (x_2 \wedge x_3)$ to Conjunctive Normal Form (CNF).
2. Consider a formula that contains the following set of clauses.

$$C_1 = (\neg x_1 \vee x_2),$$

$$C_2 = (\neg x_1 \vee x_3 \vee x_5),$$

$$C_3 = (\neg x_2 \vee x_4),$$

$$C_4 = (\neg x_3 \vee \neg x_4),$$

$$C_5 = (x_1 \vee x_5 \vee \neg x_2),$$

$$C_6 = (x_2 \vee x_3),$$

$$C_7 = (x_2 \vee \neg x_3),$$

$$C_8 = (x_6 \vee \neg x_5)$$

   a. Draw a partial implication graph for decision level 6, after a decision $x_1 = 1$.
   b. Draw a partial implication graph after learning a conflict clause $C_9 = (x_5 \vee \neg x_1)$ and backtracking to level 3.

3. Prove the equivalence between the following two programs by replacing the multiplications with uninterrupted functions.

```
int power3(int in) {
int i, out_a;
    out_a = in;
    for (i = 0; i < 2; i++)
        out_a = out_a * in;
    return out_a; }
```

```
int power3_new(int in) {
int out_b;

    out_b = (in * in) * in;
    return out_b; }
```

4. Give the algorithm to convert a formula in Equality Logic to an equisatisfiable formula in Propositional Logic.
5. Consider the following system of constraints.

$$\begin{aligned} x_1 - x_2 &\leq 0 \\ x_1 - x_3 &\leq 0 \\ -x_1 + x_2 + 2x_3 &\leq 0 \\ -x_3 &\leq -1 \end{aligned}$$

Use Fourier-Motzkin variable elimination method to check whether the system is satisfiable or not.

Part B

(Answer any 5 questions. Each question carries 7 marks) 5x7 = 35 Marks

6.
   a. Let T_1 and T_2 be two theories whose satisfiability problem is decidable and in the same complexity class. Is the satisfiability problem in a T_1 formula reducible to a satisfiability problem in T_2 formula? Why?
   b. Let T_1 T_2 be two theories whose satisfiability problems are reducible to one another. Are they in the same complexity class? Why?
7. Explain any three decision heuristics used in SAT solvers.
8. Given BDDs for $B = (x_1 \Leftrightarrow x_2)$and $B' = \neg x_2$, compute the BDD for $B \vee B'$.
9. Illustrate how uninterpreted functions can be used for verifying a compilation process with translation validation.
10. Give the algorithm to simplify an equality logic formula. Illustrate with an example.
11. Use general simplex method to check satisfiability of the following set of constraints:

$$\begin{aligned} x + y &\geq 2 \wedge \\ 2x - y &\geq 0 \wedge \\ -x + 2y &\geq 1 \end{aligned}.$$

12. A 0-1 integer linear system is an integer linear system in which all variables are constrained to be either 0 or 1. Show how a 0-1 integer linear system can be translated to a Boolean formula. What is the complexity of the translation?

Syllabus

Module 1: Introduction and Basic Concepts

Two approaches to Formal Reasoning, Basic Definitions, Normal forms and their properties, The theoretical point of view, Expressiveness vs. Decidability, Boolean structure in Decision Problems.

Module 2 : Decision Procedures for Propositional Logic

Propositional Logic, SAT Solvers, Binary Decision Diagrams

Module 3 : Equality Logic and Uninterpreted Functions

Introduction, Uninterpreted Functions, From Uninterpreted Functions to Equality Logic, Functional Consistency is not enough, Two examples of the use of Uninterpreted Functions.

Module 4 : Decision Procedures for Equality Logic and Uninterpreted Functions

Congruence Closure, Basic Concepts, Simplification of the formula, A Graph-Based Reduction to Propositional Logic, Equalities and Small Domain Instantiations, Ackermann's vs. Bryant's Reduction.

Module 5 : Linear Arithmetic

Introduction, The Simplex Algorithm, The Branch and Bound Method, Fourier-Motzkin Variable Elimination, The Omega Test, Preprocessing, Difference Logic.

Course Plan

No	Topic	No. of Lectures (40 hrs)
1	**Module 1: Introduction and Basic Concepts**	**6**
1.1	Two approaches to formal reasoning – Proof by deduction, Proof by enumeration, Deduction and enumeration	1
1.2	Basic definitions	1
1.3	Normal forms and their properties (Lecture 1)	1
1.4	Normal forms and their properties (Lecture 1)	1
1.5	The theoretical point of view	1
1.6	Expressiveness vs. Decidability, Boolean structure in decision problems	1
2	**Module 2: Decision Procedures for Propositional Logic**	**8**
2.1	Propositional Logic – Introduction	1

2.2	SAT solvers – Introduction, The *Davis-Putnam-Loveland-Logemann (DPLL)* framework	1
2.3	Boolean Constraints Propagation (BCP) and Implication Graph	1
2.4	Conflict Clauses and Resolution	1
2.5	Decision Heuristics	1
2.6	The Resolution Graph and the Unsatisfiable Core	1
2.7	Binary Decision Diagrams (Lecture 1)	1
2.8	Binary Decision Diagrams (Lecture 2)	1
3	**Module 3: Equality Logic and Uninterpreted Functions**	**7**
3.1	Introduction – Complexity and Expressiveness, Boolean Variables, Removing the Constraints	1
3.2	Uninterpreted Functions – How they are used	1
3.3	Proving equivalence of programs	1
3.4	From Uninterpreted Functions to Equality Logic – Ackermann's Reduction	1
3.5	From Uninterpreted Functions to Equality Logic – Bryant's Reduction	1
3.6	Functional Consistency is not enough	1
3.7	Two examples of the use of Uninterpreted Functions – Proving equivalence of circuits, Verifying a compilation process with Translation Validation	1
4	**Module 4: Decision Procedures for Equality Logic and Uninterpreted Functions**	**8**
4.1	Deciding a conjunction of Equalities and Uninterpreted Functions with Congruence Closure	1
4.2	Basic Concepts	1
4.3	Simplifications of the formula	1
4.4	A Graph-Based Reduction to Propositional Logic	1
4.5	Equalities and Small-Domain Instantiations – Some Simple Bounds, Graph-Based Domain Allocation	1
4.6	The Domain Allocation Algorithm	1
4.7	A Proof of Soundness	1
4.8	Ackermann's vs. Bryant's Reduction: Where does it matter?	1
5	**Module 5: Linear Arithmetic**	**11**

5.1	Basic Definitions, Solvers for Linear Arithmetic	1
5.2	The Simplex Algorithm – The basics	1
5.3	Simplex with Upper and Lower Bounds, Incremental Problems	1
5.4	The Branch and Bound Method	1
5.5	Cutting-Planes	1
5.6	Fourier-Motzkin Variable Elimination	1
5.7	The Omega Test (Lecture 1)	1
5.8	The Omega Test (Lecture 2)	1
5.9	The Omega Test (Lecture 3)	1
5.10	Preprocessing	1
5.11	Difference Logic	1

References

1. Daniel Kroening andOferStrichman. Decision Procedures – An Algorithmic Point of View, Springer, 2008.
2. ChristelBaier and Joost-Pieter Katoen. Principles of Model Checking, The MIT Press.
3. Michael Huth and Mark Ryan. Logic in Computer Science – Modelling and Reasoning about Systems, Cambridge University Press.

221ECS006	ADVANCED COMPUTER NETWORKS	CATEGORY	L	T	P	CREDIT
		PROGRAM ELECTIVE 2	3	0	0	3

Preamble: This course enables the learners to get a good grasp of emerging technologies in the field of computer networks. The syllabus dwells at length on wireless networking, as well as solutions for problems faced while efficiently routing data. Newer networking applications and protocols particularly in multimedia are introduced. The learners are given a glimpse of recent trends in networking like software defined networking. The course enables the learners to analyze network protocols and develop network based applications.

Course Outcomes: After the completion of the course the student will be able to

CO 1	Examine the problem of scalability for routing and also identify the challenges in mobile and multicast routing. (**Cognitive knowledge Level: Analyze**)
CO 2	Choose the technique that provides the Quality-of-Service needs of a particular application. (**Cognitive knowledge Level: Apply**)
CO 3	Survey various wired and wireless networking technologies including wireless cellular technologies. (**Cognitive knowledge Level: Analyze**)
CO 4	Classify the multimedia applications in the Internet and compile the various protocols handling these applications. (**Cognitive knowledge Level: Analyze**)
CO 5	Describe examples of current networking trends and identify the technological gaps. (**Cognitive knowledge Level: Evaluate**)

Program Outcomes (PO)

Outcomes are the attributes that are to be demonstrated by a graduate after completing the course.

PO1: An ability to independently carry out research/investigation and developmentwork in engineering and allied streams

PO2: An ability to communicate effectively, write and present technical reports on complex engineering activities by interacting with the engineering fraternity and with society at large.

PO3: An ability to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program

PO4: An ability to apply stream knowledge to design or develop solutions for real world problems by following the standards

PO5: An ability to identify, select and apply appropriate techniques, resources and state-ofthe-art tool to model, analyse and solve practical engineering problems.

PO6: An ability to engage in life-long learning for the design and development related to the stream related problems taking into consideration sustainability, societal, ethical and environmental aspects

PO7: An ability to develop cognitive load management skills related to project management and finance which focus on Entrepreneurship and Industry relevance.

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
CO 1	✓		✓	✓	✓	✓	
CO 2	✓		✓	✓	✓	✓	
CO 3	✓		✓	✓	✓	✓	
CO 4	✓		✓	✓	✓	✓	
CO 5	✓	✓	✓	✓	✓	✓	✓

Assessment Pattern

Bloom's Category	End Semester Examination
Apply	70%-80%
Analyze	30%-40%
Evaluate	
Create	

Mark distribution

Total Marks	CIE	ESE	ESE Duration
100	40	60	2.5 hours

Continuous Internal Evaluation Pattern:

Evaluation shall only be based on application, analysis or design based questions (for both internal and end semester examinations).

Continuous Internal Evaluation: 40 marks

i. Preparing a review article based on peer reviewed original publications (minimum 10 publications shall be referred) : 15 marks

ii Course based task / Seminar/ Data collection and interpretation : 15 marks

iii. Test paper (1 number) : 10 marks

Test paper shall include minimum 80% of the syllabus.

Course based task/test paper questions shall be useful in the testing of knowledge, skills, comprehension, application, analysis, synthesis, evaluation and understanding of the students.

End Semester Examination Pattern:

The end semester examination will be conducted by the respective College.

There will be two parts; Part A and Part B.

Part A will contain 5 numerical/short answer questions with 1 question from each module, having 5 marks for each question. Students should answer all questions. Part B will contain 7 questions (such questions shall be useful in the testing of overall achievement and maturity of the students in a course, through long answer questions relating to theoretical/practical knowledge, derivations, problem solving and quantitative evaluation), with minimum one question from each module of which student should answer any five. Each question can carry 7 marks

Total duration of the examination will be 150 minutes.

Note: The marks obtained for the ESE for an elective course shall not exceed 20% over the average ESE mark % for the core courses. ESE marks awarded to a student for each elective course shall be normalized accordingly.

For example if the average end semester mark % for a core course is 40, then the maximum eligible mark % for an elective course is 40+20 = 60 %.

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Examine how IPV6 deals with the scalability problem in routing.

2 Distinguish the various approaches in multicast routing.

3. How is the problem of mobility solved in mobile routing?

Course Outcome 2 (CO2)

1. List the categories of service offered by ISA.
2. Examine the role of MPLS in Internet traffic management.
3. Examine the issues affecting network performance and suggest solutions for the same.

Course Outcome 3(CO3):

1. Choose the network technology that can be used to cover areas that cannot support sufficient infrastructure.
2. Show the evolution of cellular technologies from 3G to 5G.
3. Compare the media access techniques of Bluetooth and Zigbee.

Course Outcome 4 (CO4):

1. Categorize the multimedia applications on the Internet and briefly explain their characteristics.
2. Illustrate how real time protocols support interactive applications like VoIP.
3. Justify the need for compressing audio and video before sending it over the Internet.

Course Outcome 5 (CO5):

1. How do overlay networks introduce new functionality into the Internet?
2. Point out the concept behind software defined networking.
3. A new routing protocol is to be implemented in the SDN control plane. Choose the appropriate layer where it should be implemented giving reasons for the same.

Model Question Paper

QP CODE:

Reg No: _____

Name: _____ **PAGES :** 2

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

FIRST SEMESTER M.TECH DEGREE EXAMINATION, MONTH & YEAR

Course Code: 221ECS006

Course Name: Advanced Computer Networks

Max. Marks : 60 **Duration: 2.5 Hours**

PART A

Answer All Questions. Each Question Carries 5 Marks

1. Illustrate with an example how standard TCP can be enhanced to support mobile users. **(5)**

2. Explain the architectural framework for supporting Quality of Service in packet networks. **(5)**

3. Examine the role of core network in 3G cellular data network. **(5)**

4. There is one sender and eight receivers in a real time multimedia communication system. If the sender is sending multimedia data at 2 Mbps, how many RTCP packets can be sent by the sender and each receiver in a second? The system allocates 75 percent of the RTCP bandwidth to the receivers and 25 percent to the sender. The average size of each RTCP packet is 125 bytes. **(5)**

5. Define OpenFlow specification used in SDN. **(5)**

Part B

(Answer any five questions. Each question carries 7 marks)

6. (a) X, Y, Z are three Ass. X and Z are connected through Y. X has a peering agreement with Y and Y with Z. Z moves all traffic from Y but does not forward traffic from X. Can Z use BGP to implement this policy? **(4)**

(b) How does PIM solve the scalability problem of existing multicast protocols. **(3)**

7. (a) Derive the hexadecimal form of representation of the following link local multicast address: **(4)**

(i) a permanently-assigned multicast group address of 66

(ii) a transient multicast group address of 316

(b) A foreign network has a foreign agent. Explain if it is possible for two mobile nodes in the foreign network to use the same care-of address in mobile IP. **(3)**

8. (a) Justify the need for Resource Reservation in multicast transmission. **(4)**

(b) How is VPN implemented using MPLS? **(3)**

9. (a) Elaborate on the various elements of 4G LTE network and the interaction between them. **(5)**

(b) Calculate the minimum time required to download $2*10^6$ bytes using ADSL modem with minimum rate. **(2)**

10. (a) Sketch the superframe format of Zigbee 802.15.4 standard. **(3)**

(b) Name some applications which use Zigbee standard and justify its use. **(4)**

11. Describe H323 architectural model for Internet Telephony. **(7)**

12. (a) Comment on the statement "Distributed Hash Tables are said to build structured P2P networks". **(4)**

(b) Explain Data Center Networking. **(3)**

Syllabus

Module 1: Advanced Internetworking

The Global Internet, Routing Areas, Interdomain Routing -BGP, IP Version 6, Multicast, Multicast Addresses, Multicast Routing -DVMRP-PIM-MSDP, Routing to a mobile node, Mobile IP, TCP and Mobility, Mobile TCP

Module 2: Internetwork Quality of Service

QoS Architectural Framework - Integrated Services Architecture – RSVP - Differentiated Services, Multiprotocol Label Switching- Destination-Based Forwarding - Explicit Routing Virtual Private Networks and Tunnels, Performance issues in networks, Delay Tolerant Networking

Module 3: Networking Technologies

Wired: DSL, Cable Networks, SONET, ATM, VLAN, Wireless: Satellite Networks,

WiMAX.Cellular Networks: Introduction-Wireless links and Network characteristics -CDMA, Cellular Internet access -An overview of cellular network architecture, 3G cellular data networks, 4G LTE Cellular networks - LTE Protocol Stacks -LTE Radio Access Network -Additional LTE functions, 5G Cellular networks, Managing mobility in cellular networks, Wireless and Mobility-Impact on higher level protocols, Personal Area Networks: Bluetooth, Zigbee

Module 4: Networking Applications

Multimedia in the Internet: Streaming stored audio/video, Streaming live audio/video, Real time interactive audio/video, Real time Interactive Protocols: RTP- RTCP-SIP-H.323, SCTP Compression: Audio Compression, Image compression- JPEG, Video Compression- MPEG

Module 5: Current Topics in Networking

Overlay Networks: Routing overlays -Resilient overlay networks, Peer-Peer Networks – Bit Torrent-Distributed Hash Tables, Content Distribution networks, Software Defined Networks: Architecture – Control and Data Planes – Open Flow – SDN Controllers, Network Function Virtualization, Data Center Networking

Course Plan

No	Topic	No. of Lectures (40 hrs)
1	**Module 1: Advanced Internetworking**	**8**
1.1	The Global Internet, Routing Areas	1
1.2	Inter-domain Routing -BGP	1
1.3	IP Version 6	1
1.4	Multicast, Multicast Addresses	1
1.5	Multicast Routing – DVMRP	1
1.6	PIM, MSDP	1
1.7	Routing to a mobile node, Mobile IP	1
1.8	TCP and Mobility, Mobile TCP	1
2	**Module 2: Internetwork Quality of Service**	**8**

2.1	QoS Architectural Framework	1
2.2	Integrated Services Architecture	1
2.3	RSVP - Differentiated Services	1
2.4	Multiprotocol Label Switching,	1
2.5	Virtual Private Networks and Tunnels	1
2.6	Destination-Based Forwarding - Explicit Routing	1
2.7	Performance issues in networks	1
2.8	Delay Tolerant Networking	1
3	**Module 3: Networking Technologies**	**9**
3.1	Wired: DSL, Cable Networks, SONET,	1
3.2	ATM, VLAN	1
3.3	Wireless: Satellite Networks, WiMAX	1
3.4	Cellular Networks: Introduction-Wireless links and Network characteristics - CDMA,	1
3.5	Cellular Internet access-An overview of cellular network architecture, 3G cellular data networks,	1
3.6	4G LTE Cellular networks - LTE Protocol Stacks -LTE Radio Access Network - Additional LTE functions	1
3.7	5G Cellular networks	1
3.8	Managing mobility in cellular networks, Wireless and Mobility-Impact on higher level protocols	1
3.9	Personal Area Networks: Bluetooth, Zigbee	1
4	**Module 4: Networking Applications**	**7**

4.1	Multimedia in the Internet: Streaming stored audio/video, Streaming live audio/video,	1
4.2	Real time interactive audio/video	1
4.3	Real time Interactive Protocols: RTP- RTCP	1
4.4	H-323	1
4.5	SIP, SCTP	1
4.6	Compression: Audio Compression, Image compression- JPEG,	1
4.7	Video Compression- MPEG	1
5	**Module 5: Current Topics in Networking**	**8**
5.1	Overlay Networks: Routing overlays	1
5.2	-Resilient overlay networks,	1
5.3	Peer-Peer Networks – Bit Torrent – Distributed Hash Tables,	1
5.4	Content Distribution networks	1
5.5	Software Defined Networks: Architecture – Control and Data Planes	1
5.6	Open Flow, SDN Controllers	1
5.7	Network Function Virtualization	1
5.8	Data Center Networking	1

References

1. Larry Peterson and Bruce Davie, Computer Networks - A Systems Approach, Morgan Kaufmann, 6th edition, 2022

2. James F. Kurose and Keith W. Ross, Computer Networking A Top-Down Approach, Pearson, 8th edition, 2022

3. Jochen Schiller, Mobile Communications, Addison-Wesley, 2nd edition, 2003

4. William Stallings, Data and Computer Communications, Pearson, 5th edition, 2017

5. Andrew Tanenbaum and David Wetherall, Computer Networks, Pearson, 5th edition, 2010

6. Behrouz A Forouzan, Data Communications and Networking, McGraw Hill, 5th edition, 2017

7. Thomas D. Nadeau and Ken Gray, SDN – Software Defined Networks, O'Reilly, 2013

221ECS007	PATTERN RECOGNITION	CATEGORY	L	T	P	CREDIT
		PROGRAM ELECTIVE 2	3	0	0	3

Preamble: This course aims to impart the fundamentals of statistical pattern recognition and neural network techniques. It introduces to the learner the various pattern recognition algorithms, feature selection, classification, clustering and the use of neural networks in feature extraction. This helps the learner to apply the algorithms in applications that works on pattern recognition and machine intelligence.

Course Outcomes: After the completion of the course the student will be able to

CO 1	Apply probability and numerical methods in statistical pattern recognition. **(Cognitive Knowledge Level: Apply)**
CO 2	Apply statistical methods in feature selection.**(Cognitive Knowledge Level: Apply)**
CO 3	Apply linear algebra and statistical methods in parameter and non-parameter estimation.**(Cognitive Knowledge Level: Apply)**
CO 4	Apply the technique of decision trees in pattern recognition. **(Cognitive Knowledge Level: Apply)**
CO 5	Analyze the use of deep learning networks andartificial neural networks in pattern recognition. **(Cognitive Knowledge Level: Analyze)**
CO 6	Design, Develop, Implement and Present innovative ideas in problem solving with various pattern recognition techniques. **(Cognitive Knowledge Level: Create)**

Program Outcomes (PO)

Outcomes are the attributes that are to be demonstrated by a graduate after completing the course.

PO1: An ability to independently carry out research/investigation and developmentwork in engineering and allied streams

PO2: An ability to communicate effectively, write and present technical reports on complex engineering activities by interacting with the engineering fraternity and with society at large.

PO3: An ability to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program

PO4: An ability to apply stream knowledge to design or develop solutions for real world problems by following the standards

PO5: An ability to identify, select and apply appropriate techniques, resources and state-of-the-art tool to model, analyse and solve practical engineering problems.

PO6: An ability to engage in life-long learning for the design and development related to the stream related problems taking into consideration sustainability, societal, ethical and environmental aspects

PO7: An ability to develop cognitive load management skills related to project management and finance which focus on Entrepreneurship and Industry relevance.

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
CO 1	✓		✓	✓	✓	✓	
CO 2	✓		✓	✓	✓	✓	
CO 3	✓		✓	✓	✓	✓	
CO 4	✓		✓	✓	✓	✓	
CO 5	✓		✓	✓	✓	✓	
CO 6	✓	✓	✓	✓	✓	✓	✓

Assessment Pattern

Bloom's Category	End Semester Examination
Apply	70%-80%
Analyze	30%-40%
Evaluate	
Create	

Mark distribution

Total Marks	CIE	ESE	ESE Duration
100	40	60	2.5 hours

Continuous Internal Evaluation Pattern:

Evaluation shall only be based on application, analysis or design-based questions (for both internal and end semester examinations).

Continuous Internal Evaluation: 40 marks

i. Preparing a review article based on peer reviewed original publications (minimum 10 publications shall be referred) : 15 marks

ii. Course based task / Seminar/ Data collection and interpretation : 15 marks

iii. Test paper (1 number) : 10 marks

Test paper shall include minimum 80% of the syllabus.

Course based task/test paper questions shall be useful in the testing of knowledge, skills, comprehension, application, analysis, synthesis, evaluation and understanding of the students.

End Semester Examination Pattern:

The end semester examination will be conducted by the respective College.

There will be two parts; Part A and Part B.

Part A will contain 5 numerical/short answer questions with 1 question from each module, having 5 marks for each question. Students should answer all questions. Part B will contain 7 questions (suchquestions shall be useful in the testing of overall achievement and maturity of thestudents in a course, through long answer questions relating totheoretical/practical knowledge, derivations, problem solving and quantitativeevaluation), with minimum one question from each module of which studentshould answer any five. Each question can carry 7 marks

Total duration of the examination will be 150 minutes.

Note: The marks obtained for the ESE for an elective course shall not exceed 20% over the average ESE mark % for the core courses. ESE marks awarded to a student for each elective course shall be normalized accordingly.

For example, if the average end semester mark % for a core course is 40, then the maximum eligible mark % for an elective course is 40+20 = 60 %.

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Illustrate the design cycle of a pattern recognition system with the help of an example.
2. Suppose that we have three coloured bottles r (red), b(blue) and g(green).Box r contains 3 apples, 4 oranges and 3 limes. Box B contains 1 apple, 1 orange and 0 limes and box g contains 3 apples, 3 oranges and 4 limes. If a box is chosen at random with probability p(g)=0.2, p(b)=0.2 and p(g)=0.6 and piece of fruit is removed from the box(with equal probability of selecting items from the box), then what is the probability of selecting an apple? If we observe that the selected fruit is in fact an orange, what is the probability that it came from the green box?

Course Outcome 2 (CO2):

1. Illustrate feature selection using t-Test with the help of an example.

Course Outcome 3(CO3):

1. Derive the fuzzy C spherical shells (FCSS) algorithm for the case that spherical clusters are to be identified.

Course Outcome 4 (CO4):

1. Illustrate decision tree with the help of an example. How does it enable pattern classification?

2. Construct a decision tree using the following data.

Outlook	Temp	Humidity	Windy	Play Golf
Rainy	Hot	High	False	No
Rainy	Hot	High	True	No
Cloudy	Hot	High	False	Yes
Sunny	Mild	High	False	Yes
Sunny	Cool	Normal	False	Yes
Sunny	Cool	Normal	True	No
Cloudy	Cool	Normal	True	Yes
Rainy	Mild	High	False	No
Rainy	Mild	Normal	False	Yes
Sunny	Mild	Normal	False	Yes
Rainy	Cool	Normal	True	Yes
Cloudy	Mild	High	True	Yes
Cloudy	Mild	Normal	False	Yes
Sunny	Hot	High	True	No

Course Outcome 5 (CO5):

1. How do artificial neural networks play a significant role in pattern recognition? Also discuss about its parameter optimisation techniques.

Course Outcome 6 (CO6):

1. Suppose an accident-prone area is under surveillance and real time CCTV visuals are available to you. Design a solution to automatically detect accidents on the road from those real time CCTV visuals. Explain about any one pattern recognition algorithm you will make use here and how?

Model Question Paper

QP CODE:

Reg No: _____

Name: _____ **PAGES: 2**

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

FIRST SEMESTER M.TECH DEGREE EXAMINATION, MONTH & YEAR

Course Code: 221ECS007

Course Name: Pattern Recognition

Max. Marks : 60 **Duration: 2.5 Hours**

PART A

Answer All Questions. Each Question Carries 5 Marks

1.	In a town it was estimated that 3% of people have a particular disease. Adiagnosis test was conducted for all the people, which yielded 8% false positiveand 92% true positive results. A person is found as positive after the test. What isthe probability that this person is truly having the disease?	**(5)**
2.	How does morphological operations play a role in pattern recognition?	**(5)**
3.	How can visual imagery be analysed using convolutional neural networks?	**(5)**
4.	How does a decision tree handle continuous attributes?	**(5)**
5.	Define the terms: weights, bias, activations with respect to neural networks	**(5)**

Part B

(Answer any five questions. Each question carries 7 marks)

6.	Illustrate the design principles of pattern recognition system with an example.	**(7)**
7.	Derive the fuzzy C spherical shells (FCSS) algorithm for the case that spherical clusters are to be identified.	**(7)**

8. Show that in the case of Gaussian distributions the Chernoff bound becomes **(7)**

$$\epsilon_{CB} = \exp(-b(s))$$

where

$$b(s) = \frac{s(1-s)}{2}(\boldsymbol{\mu}_i - \boldsymbol{\mu}_j)^T [s\Sigma_j + (1-s)\Sigma_i]^{-1}(\boldsymbol{\mu}_i - \boldsymbol{\mu}_j) + \frac{1}{2}\ln\frac{|\, s\Sigma_j + (1-s)\Sigma_i \,|}{|\, \Sigma_j \,|^s |\, \Sigma_i \,|^{1-s}}$$

Then take the derivative with respect to s and show that for equal covariance matrices the optimum is achieved for $s = 1/2$. Thus, in this case $b(s)$ equals the Bhattacharyya distance.

9. Let N_1, N_2 be the available values of a feature in two classes, respectively. The feature is assumed to follow a Gaussian distribution with the same variance in each class. Define the test statistic **(7)**

$$q = \frac{(\bar{x} - \bar{y}) - (\mu_1 - \mu_2)}{s_z\sqrt{\frac{1}{N_1} + \frac{1}{N_2}}}$$

where

$$s_z^2 = \frac{1}{N_1 + N_2 - 2}\left(\sum_{i=1}^{N_1}(x_i - \bar{x})^2 + \sum_{i=1}^{N_2}(y_i - \bar{y})^2\right)$$

and μ_1, μ_2 are the respective true mean values. Show that q follows the t-distribution with $N_1 + N_2 - 2$ degrees of freedom.

10. Discuss the significance of pre-processing in feature selection. Illustrate any two methods used for pre-processing. **(7)**

11. How can artificial neural networks be applied in Pattern recognition? Also illustrate the features of recurrent neural networks. **(7)**

12. Construct a decision tree using the following data. **(7)**

Outlook	Temp	Humidity	Windy	Play Golf
Rainy	Hot	High	False	No
Rainy	Hot	High	True	No
Cloudy	Hot	High	False	Yes
Sunny	Mild	High	False	Yes
Sunny	Cool	Normal	False	Yes
Sunny	Cool	Normal	True	No
Cloudy	Cool	Normal	True	Yes
Rainy	Mild	High	False	No
Rainy	Mild	Normal	False	Yes
Sunny	Mild	Normal	False	Yes
Rainy	Cool	Normal	True	Yes
Cloudy	Mild	High	True	Yes
Cloudy	Mild	Normal	False	Yes
Sunny	Hot	High	True	No

Syllabus

Module 1: Introduction to Pattern Recognition

Basics of pattern recognition systems, various applications, Machine Perception, classification of pattern recognition systems. Design of Pattern recognition system, Pattern recognition Life Cycle. Statistical Pattern Recognition: Review of probability theory, Gaussian distribution. Normal density and discriminant functions.

Module 2: Feature Selection

Feature selection – Outlier removal – Data normalization – Missing data, The Peaking phenomenon, Feature selection using statistical hypothesis testing- Hypothesis testing basics – Application of t-Test in feature selection. Class separability measures-Divergence-Chernoff bound and Bhattacharya distance-Scatter matrices, Feature subset selection –Scalar feature selection, Feature vector selection.

Module 3: Clustering Algorithms

Unsupervised learning and clustering - Criterion functions for clustering. Cluster validation. Fuzzy clustering algorithms- Point representatives- quadratic surfaces and representatives – hyper plane representatives. Binary morphology clustering algorithms (BMCAs) – Discretization – Morphological operations - Determination of clusters in a discrete binary set-

Assignment of feature vectors to clusters – The algorithmic scheme, Boundary detection algorithms.

Module 4: Dimensionality reduction

Dimensionality reduction: Principal component analysis - its relationship to Eigen analysis. Fisher discriminant analysis - Generalised Eigen analysis. Eigen vectors/Singular vectors as dictionaries. Factor Analysis, Total variability space - a dictionary learning method.Non negative matrix factorisation - a dictionary learning method.
Linear discriminant functions: Gradient descent procedures, Perceptron.

Module 5: Artificial neural networks and Pattern Classification

Artificial neural networks: Review of Artificial neural network concepts, convolutional neural networks, recurrent neural networks.
Non-metric methods for pattern classification: non-numeric data or nominal data. Decision trees: Classification and Regression Trees (CART).

Course Plan

No.	Topic	No. of Lectures (**40 Hours**)
1	**Module 1: Introduction to Pattern Recognition**	**7**
1.1	Basics of pattern recognition systems, applications	1
1.2	Machine Perception, Classification of pattern recognition systems	1
1.3	Design of Pattern recognition system	1
1.4	Pattern recognition Life Cycle	1
1.5	Statistical Pattern Recognition	1
1.6	Review of probability theory	1
1.7	Normal density and discriminant functions	1
2	**Module 2: Feature Selection**	**10**
2.1	Feature selection – Outlier removal	1
2.2	Data normalization – Missing data	1
2.3	The peaking phenomenon	1
2.4	Feature selection using statistical hypothesis testing	1

2.5	Hypothesis testing basics – Application of tTest in feature selection	1
2.6	Class separability measures-Divergence	1
2.7	Chernoff bound and Bhattacharya distance	1
2.8	Scatter matrices	1
2.9	Feature subset selection –Scalar feature selection	1
2.10	Feature vector selection	1
3	**Module 3: Clustering Algorithms**	**9**
3.1	Unsupervised learning and clustering	1
3.2	Criterion functions for clustering. Cluster validation.	1
3.3	Fuzzy clustering algorithms- Point representatives	1
3.4	Quadratic surfaces and representatives – hyper plane representatives.	1
3.5	Binary morphology clustering algorithms (BMCAs)	1
3.6	Discretization	1
3.7	Morphological operations - Determination of clusters in a discrete binary set	1
3.8	Assignment of feature vectors to clusters	1
3.9	The algorithmic scheme, Boundary detection algorithms.	1
4	**Module 4: Dimensionality reduction**	**8**
4.1	Principal component analysis - its relationship to Eigen analysis	1
4.2	Fisher discriminant analysis	1
4.3	Generalised Eigen analysis	1
4.4	Eigen vectors/Singular vectors as dictionaries	1
4.5	Total variability space - a dictionary learning method	1
4.6	Non negative matrix factorisation - a dictionary learning method	1
4.7	Linear discriminant functions: Gradient descent procedures	1
4.8	Perceptron	1
5	**Module 5: Artificial neural networks and Pattern Classification**	**6**
5.1	Review of Artificial neural networks, Introduction to deep neural networks	1
5.2	Convolutional neural networks	1
5.3	Recurrent neural networks	1
5.4	Non-metric methods for pattern classification: Non-numeric data or nominal data	1
5.5	Decision trees: Classification and Regression Trees (CART) lecture 1	1
5.6	Decision trees: Classification and Regression Trees (CART) lecture 2	1

References

1. S.Theodoridis and K.Koutroumbas, “Pattern Recognition”, 4th Ed., Academic Press, 2009

2. C.M.Bishop, “Pattern Recognition and Machine Learning”, Springer, 2006

3. R.O.Duda, P.E.Hart and D.G.Stork, “Pattern Classification”, John Wiley, 2001

4. Hastie, T., Tibshirani, R. and Friedman, J. “The Elements of Statistical Learning”. Springer. 2001.

221ECS008	ADVANCED COMPUTER ARCHITECTURE	CATEGORY	L	T	P	CREDIT
		PROGRAM ELECTIVE 2	3	0	0	3

Preamble: This purpose of this course is to provide a solid foundation that furnishes the learner with in-depth knowledge of current and emerging trends in computer architectures, focusing on performance and the hardware/software interface. This course covers design and analysis, memory hierarchy, pipelining, operation of multiprocessors, thread level parallelism, and data level parallelism. This course helps the learner to develop software/hardware applications based on architectural framework.

Course Outcomes: After the completion of the course the student will be able to

CO 1	Identify and solve the advanced issues in design of computer processors, caches and memory**(Cognitive Knowledge Level: Apply)**
CO 2	Analyze the memory hierarchy design, performance improvement techniques and cache optimization techniques**(Cognitive Knowledge Level: Analyze)**
CO 3	Analyze the working and features of branching and exception handling in pipeline architecture**(Cognitive Knowledge Level: Analyze)**
CO 4	Analyze the operation of multiprocessors and thread level parallelism**(Cognitive Knowledge Level: Evaluate)**
CO 5	Demonstrate the concepts of data level parallelism including SIMD and GPU processors**(Cognitive Knowledge Level: Apply)**
CO 6	Design, Develop, Implement and Present innovative ideas on advanced computer architecture and techniques. **(Cognitive Knowledge Level: Create)**

Program Outcomes (PO)

Outcomes are the attributes that are to be demonstrated by a graduate after completing the course.

PO1: An ability to independently carry out research/investigation and development work in engineering and allied streams

PO2: An ability to communicate effectively, write and present technical reports on complex engineering activities by interacting with the engineering fraternity and with society at large.

PO3: An ability to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program

PO4: An ability to apply stream knowledge to design or develop solutions for real world problems by following the standards

PO5: An ability to identify, select and apply appropriate techniques, resources and state-of-the-art tool to model, analyse and solve practical engineering problems.

PO6: An ability to engage in life-long learning for the design and development related to the stream related problems taking into consideration sustainability, societal, ethical and environmental aspects

PO7: An ability to develop cognitive load management skills related to project management and finance which focus on Entrepreneurship and Industry relevance.

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
CO 1			✓	✓	✓	✓	
CO 2			✓	✓	✓	✓	
CO 3			✓	✓	✓	✓	
CO 4			✓	✓		✓	
CO 5	✓		✓	✓	✓	✓	
CO 6	✓	✓	✓	✓	✓	✓	✓

Assessment Pattern

Bloom's Category	End Semester Examination
Apply	70%-80%
Analyze	30%-40%
Evaluate	
Create	

Mark distribution

Total Marks	CIE	ESE	ESE Duration
100	40	60	2.5 hours

Continuous Internal Evaluation Pattern:

Evaluation shall only be based on application, analysis or design-based questions (for both internal and end semester examinations).

Continuous Internal Evaluation: 40 marks

i. Preparing a review article based on peer reviewed original publications (minimum 10 publications shall be referred) : 15 marks

ii. Course based task / Seminar/ Data collection and interpretation : 15 marks

iii. Test paper (1 number) : 10 marks

Test paper shall include minimum 80% of the syllabus.

Course based task/test paper questions shall be useful in the testing of knowledge, skills, comprehension, application, analysis, synthesis, evaluation and understanding of the students.

End Semester Examination Pattern:

The end semester examination will be conducted by the respective College.

There will be two parts; Part A and Part B.

Part A will contain 5 numerical/short answer questions with 1 question from each module, having 5 marks for each question. Students should answer all questions. Part B will contain 7 questions (such questions shall be useful in the testing of overall achievement and maturity of the students in a course, through long answer questions relating to theoretical/practical knowledge, derivations, problem solving and quantitative evaluation), with minimum one question from each module of which student should answer any five. Each question can carry 7 marks

Total duration of the examination will be 150 minutes.

Note: The marks obtained for the ESE for an elective course shall not exceed 20% over the average ESE mark % for the core courses. ESE marks awarded to a student for each elective course shall be normalized accordingly.

For example, if the average end semester mark % for a core course is 40, then the maximum eligible mark % for an elective course is 40+20 = 60 %.

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Identify the various techniques for instruction encoding. Illustrate with examples.

Course Outcome 2 (CO2):

1. Consider an in-order execution computer. Assume that the cache miss penalty is 200 clock cycles, and all instructions normally take 1.0 clock cycles. Assume that the average miss rate is 2%, there is an average of 1.5 memory references per instruction, and the average number of cache misses per 1000 instructions is 30. What is the impact on performance when behaviour of the cache is included? Calculate the impact using both misses per instruction & miss rate.

Course Outcome 3(CO3):

1. Consider the execution of following instructions, on our pipelined example processor:

   ADD R1, R2, R3
   SUB R4, R1, R5
   AND R6, R1, R7
   OR R8, R1, R9
   XOR R10, R1, R11
   Analyze type of hazards may occur in the above code? If hazard exists, explain how we can solve it.

Course Outcome 4 (CO4):

1. Determine the limitations in symmetric shared memory multiprocessors.

Course Outcome 5 (CO5):

1. Identify the data dependencies between the statements S1 and S2 in the loop.

```
for (i=1; i<=100; i=i+1) {
A[i+1] = A[i] + C[i]; /* S1 */
B[i+1] = B[i] + A[i+1]; /* S2 */
}
```

Course Outcome 6 (CO6):

1. Implement pipelining and various level parallelisms using tools like OPENMP.

Model Question Paper

QP CODE:

Reg No: _____

Name: _____ **PAGES: 2**

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

FIRST SEMESTER M.TECH DEGREE EXAMINATION, MONTH & YEAR

Course Code: 221ECS008

Course Name: Advanced Computer Architecture

Max. Marks : 60 **Duration: 2.5 Hours**

PART A

Answer All Questions. Each Question Carries 5 Marks

1. Impact of optimization improves the performance of complier. Justify your answer. Also mention types of optimizations. **(5)**

2. Determine whether a 32 KB four-way set associative L1 cache has a faster memory access time than a 32 KB two-way set associative L1 cache. Assume the miss penalty to L2 is 15 times the access time for the faster L1 cache. Ignore misses beyond L2. Which has the faster average memory access time? (Miss rate for two-way set associative cache is 0.038 and four-way set associative cache is 0.037) **(5)**

3. Analyze the type of hazards may occur in the following code. **(5)**

```
LW R1, 0(R2)
SUB R4, R1
AND R6, R1, R7
OR R8, R1, R9
```

4. Suppose we have an application running on a 32-processor multiprocessor, which has a 200ns time to handle reference to a remote memory. For this application, assume that all the references except those involving communication hit in the local memory hierarchy, which is slightly optimistic. Processors are stalled on a remote request, and the processor clock rate is 2GHz. If the base CPI (assuming that all references hit in the cache) is 0.5, evaluate how much faster is the multiprocessor if there is no communication versus if 0.2% of the instructions involve a remote communication reference? **(5)**

5. Consider the following loops, identify the true dependencies, output dependences and anti-dependences and eliminate the output dependences and anti-dependences. **(5)**

```
for(i=0;i<100;i++){
Y[i]=X[i]/C; /*S1*/
X[i]= X[i]+C; /*S2*/
Z[i]=Y[i]+C; /*S3*/
Y[i]=C-Y[I]; /*S4*/
}
```

Part B

(Answer any five questions. Each question carries 7 marks)

6. A benchmark program is executed on a 40MHZ processor. The benchmark program has the following statistics. **(7)**

Instruction Type	Instruction Count	Clock Cycle Count
Arithmetic	45000	1
Branch	32000	2
Load/Store	15000	2
Floating Point	8000	2

Determine the effective CPI, MIPS rate and execution time of this program.

7. "Fully associative caches do not have conflict misses". Examine the statement. **(7)**

8. Consider an in-order execution computer. Assume that the cache miss penalty is 200 clock cycles, and all instructions normally take 1.0 clock cycles. Assume that the average miss rate is 2%, there is an average of 1.5 memory references per instruction, and the average number of cache misses per 1000 instructions is 30. What is the impact on performance when behaviour of the cache is included? Calculate the impact using both misses per instruction and miss rate. **(7)**

9. Explain the methodologies used for reducing the branch cost with prediction in instruction level parallelism. **(7)**

10. Illustrate and explain extending the MIPS pipeline to handle multicycle operations. **(7)**

11. Explain multiprocessor cache coherence. **(7)**

12. Compare and contrast multimedia SIMD computers and GPUs. **(7)**

Syllabus

Module 1: Design and Analysis

Principles of computer design, Fallacies and Pitfalls, Instruction Set Principles- Classifying instruction set architecture, Memory addressing, Type and size of operands, Operations in the instruction set, Instruction for control flow, Encoding an instruction set, Role of compiler.

Module 2: Memory Hierarchy

Introduction, Cache performance, Basic cache optimizations, Virtual memory–Techniques for fast address translation, Protection via virtual memory, Fallacies and Pitfalls, Case study of Pentium/Linux memory system-Pentium address translation.

Module 3: Pipelining

Introduction, Pipeline hazards, Static branch prediction and dynamic branch prediction, Implementation of MITS, Basic pipeline of MITS, Implementing the control in MITS pipeline, Dealing with branches in pipeline, Dealing with exceptions, Handling of multi-cycle operations, Maintaining precise exceptions, Case study of MITS R4000 pipeline.

Module 4: Thread Level Parallelism

Introduction, Centralized Shared-Memory Architectures, Performance of Symmetric Shared-Memory Multiprocessors, Distributed Shared-Memory and Directory-Based Coherence, Synchronization: The Basics, Models of Memory Consistency: An Introduction, Crosscutting Issues, Case study of Sun T1 Multiprocessor.

Module 5: Data Level Parallelism

Vector architecture, SIMD instruction set, Extension for multimedia, Graphic Processing Units, Case study Envida GPU instruction set architecture, GPU memory structure, Innovations in GPU architecture, Comparisons between vector architecture and GPUs, Comparisons between multimedia SIMD computers and GPUs, Loop level parallelism, Finding dependencies, Eliminating dependencies.

Course Plan

No	Topic	No. of Lectures (**40 Hours**)
1	**Module 1: Design and Analysis**	**8**
1.1	Principles of computer design	1
1.2	Fallacies and Pitfalls	1
1.3	Instruction Set Principles- Classifying instruction set architecture	1
1.4	Memory addressing, Type and size of operands	1
1.5	Operations in the instruction set	1
1.6	Instruction for control flow	1
1.7	Encoding an instruction set	1
1.8	Role of compiler	1
2	**Module 2: Memory Hierarchy**	**8**
2.1	Introduction	1
2.2	Pipeline hazards	1
2.3	Static branch prediction and dynamic branch prediction	1
2.4	Implementation of MITS, Basic pipeline of MITS	1
2.5	Implementing the control in MITS pipeline	1
2.6	Dealing with branches in pipeline, Dealing with exceptions	1
2.7	Handling of multi-cycle operations, Maintaining precise exceptions	1
2.8	Case study of MITS R4000 pipeline	1
3	**Module 3: Multiprocessors and Thread level Parallelism**	**8**
3.1	Introduction	1
3.2	Centralized Shared-Memory Architectures	1
3.3	Performance of Symmetric Shared-Memory Multiprocessors	1
3.4	Distributed Shared-Memory and Directory-Based Coherence	1
3.5	Synchronization: The Basics	1
3.6	Models of Memory Consistency: An Introduction	1
3.7	Crosscutting Issues	1
3.8	Case study Sun T1 Multiprocessor	1
4	**Module 4: Multiprocessors and Thread level Parallelism**	**8**
4.1	Introduction	1

4.2	Centralized Shared-Memory Architectures	1
4.3	Performance of Symmetric Shared-Memory Multiprocessors	1
4.4	Distributed Shared-Memory and Directory-Based Coherence	1
4.5	Synchronization: The Basics	1
4.6	Models of Memory Consistency: An Introduction	1
4.7	Crosscutting Issues	1
4.8	Case study Sun T1 Multiprocessor	1
5	**Module 5: Data Level Parallelism**	**8**
5.1	Vector architecture, SIMD instruction set	1
5.2	Extension for multimedia, Graphic Processing Units	1
5.3	Case study Envida GPU instruction set architecture	1
5.4	GPU memory structure	1
5.5	Innovations in GPU architecture, Comparisons between vector architecture and GPUs	1
5.6	Comparisons between multimedia SIMD computers and GPUs	1
5.7	Loop level parallelism	1
5.8	Finding dependencies, Eliminating Dependencies	1

References

1. Hennessy J.L and David A. Patterson “Computer Architecture- A Quantitative Approach” Morgan Kaufmann Publication, Fifth edition, 2002.
2. Randal E Bryant and David O'Hallaron “Computer Systems A programmer's perspective” Pearson Education, 2nd edition 2010.
3. Kaihwang and Naresh Jotwani, “Advanced Computer Architecture” 2nd edition Tata Mcgraw-Hill, 2010.
4. Sima D,Fountain T and Kacsuk P “Advanced Computer Architecture: A Design Space Approach” Pearson Education, 1st edition 1997.

221ECS009	NATURAL LANGUAGE PROCESSING AND TEXT MINING	CATEGORY	L	T	P	CREDIT
		PROGRAM ELECTIVE 2	3	0	0	3

Preamble: This course provides an exposure to the concepts and techniques in Natural language processing and Text mining. Fundamental concepts and practical applications of Natural Language Processing (NLP) are covered in this course. This helps the learners to analyze and interpret textual data.

Course Outcomes: After the completion of the course the student will be able to

CO 1	Apply different approaches of syntax and semantics in NLP. **(Cognitive Knowledge Level: Apply)**
CO 2	Employ approaches to generate dialogue and summarisation within NLP. **(Cognitive Knowledge Level: Apply)**
CO 3	Apply different statistical approaches to machine translation. **(Cognitive Knowledge Level: Apply)**
CO 4	Research, analyze and deploy appropriate machine learning techniques in NLP including hidden Markov models and unsupervised methods. **(Cognitive Knowledge Level: Analyze)**
CO 5	Use text mining concepts and methods to model real-world problems and develop technical solutions. **(Cognitive Knowledge Level: Analyze)**
CO6	Design, develop and implement NLP and text mining methods to solve real world problems. **(Cognitive Knowledge Level: Create)**

Program Outcomes (PO)

Outcomes are the attributes that are to be demonstrated by a graduate after completing the course.

PO1: An ability to independently carry out research/investigation and development work in engineering and allied streams

PO2: An ability to communicate effectively, write and present technical reports on complex engineering activities by interacting with the engineering fraternity and with society at large.

PO3: An ability to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program

PO4: An ability to apply stream knowledge to design or develop solutions for real world problems by following the standards

PO5: An ability to identify, select and apply appropriate techniques, resources and state-of-the-art tool to model, analyse and solve practical engineering problems.

PO6: An ability to engage in life-long learning for the design and development related to the stream related problems taking into consideration sustainability, societal, ethical and environmental aspects

PO7: An ability to develop cognitive load management skills related to project management and finance which focus on Entrepreneurship and Industry relevance.

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
CO 1	✓				✓	✓	
CO 2	✓		✓	✓	✓	✓	
CO 3	✓		✓	✓	✓	✓	
CO 4	✓		✓	✓	✓	✓	
CO 5	✓		✓	✓	✓	✓	
CO6	✓	✓	✓	✓	✓	✓	✓

Assessment Pattern

Bloom's Category	End Semester Examination
Apply	70%-80%
Analyse	30%-40%
Evaluate	
Create	

Mark distribution

Total Marks	CIE	ESE	ESE Duration
100	40	60	2.5 hours

Continuous Internal Evaluation Pattern:

Evaluation shall only be based on application, analysis or design-based questions (for both internal and end semester examinations).

Continuous Internal Evaluation: 40 marks

i. Preparing a review article based on peer reviewed original publications (minimum 10 publications shall be referred) : 15 marks

ii. Course based task / Seminar/ Data collection and interpretation : 15 marks

iii. Test paper (1 number) : 10 marks

Test paper shall include minimum 80% of the syllabus.
Course based task/test paper questions shall be useful in the testing of knowledge, skills, comprehension, application, analysis, synthesis, evaluation and understanding of the students.

End Semester Examination Pattern:

The end semester examination will be conducted by the respective College.

There will be two parts; Part A and Part B.

Part A will contain 5 numerical/short answer questions with 1 question from each module, having 5 marks for each question. Students should answer all questions. Part B will contain 7 questions (such questions shall be useful in the testing of overall achievement and maturity of the students in a course, through long answer questions relating to theoretical/practical knowledge, derivations, problem solving and quantitative evaluation), with minimum one question from each module of which student should answer any five. Each question can carry 7 marks

Total duration of the examination will be 150 minutes.

Note: The marks obtained for the ESE for an elective course shall not exceed 20% over the average ESE mark % for the core courses. ESE marks awarded to a student for each elective course shall be normalized accordingly.

For example if the average end semester mark % for a core course is 40, then the maximum eligible mark % for an elective course is 40+20 = 60 %.

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Consider the following Corpus

   - Mid priced food is what I am looking for.
   - Tell me about Thai food.
   - Can you give me a list of Thai food?
   - I am looking for a good restaurant for Thai food.

   Draw the Raw Bigram count table for the corpus and then Find the bigram probability of the sentence " I am looking for Thai food."

2. Write the Regular Expression for the following

    a. To find the all occurrence of the word **hood** in a text

    b. To find any line in which a particular word **country** appears twice

    c. To find similar pattern like ***The bigger they were, the bigger they will be*** or ***The smaller they were, the smaller they will be.***

3. Find the minimum edit distance between the string INTENTION and EXECUTION using dynamic programming.

Course Outcome 2 (CO2)

1. Consider a document collection having 37 documents. Find the cosine similarity of the words "Fool and Wit"

Words	Document Frequency
Romeo	1
Salad	2
Falstaff	4
Forest	12
Battle	21
Wit	34
Fool	36
Good	37
Sweet	37

Raw Word Count	Doc1	Doc2	Doc3	Doc4
Battle	1	0	7	13
Good	114	80	62	89
Fool	36	58	1	4
Wit	20	15	2	3

2. Explain the SND method of word embeddings generation? What are its Limitations?

Course Outcome 3(CO3):

1. Specify the roles of Named Entity Recognition in Question Answering systems?
2. Using Transition probabilities and Emission probabilities given below, POS tag the sentence **Files like a Flower** with HMM tagger

   <s> is he start symbol and wherever the transition probability is not explicitly given in the table assume the value 0.0001

Category	Bigram	Estimate
<s>	PROB(ART|<s>)	71
<s>	PROB(N|<s>)	29
ART	PROB(N|ART)	1
N	PROB(V|N)	43
N	PROB(N|N)	13
N	PROB(P|N)	44
V	PROB(N|V)	35
V	PROB(ART|V)	65
P	PROB(ART|P)	74
P	PROB(N|P)	26

PROB(the |ART)	0.54	PROB(a|ART)	0.360
PROB(files|N)	0.025	PROB(a|N)	0.001
PROB(files|V)	0.076	PROB(flowers|N)	0.063
PROB(like|V)	1	PROB(flowers|V)	0.05
PROB(like|N)	0.012		

3. Explain how a feed forward network can be used for sentiment analysis.

Course Outcome 4 (CO4):

1. Whether Bidirectional RNN can be used for sentiment classification? Justify.
2. Draw the architecture of a RNN that can be used for sequence classification.

Course Outcome 5 (CO5):

1. Consider the following sentence:
   "You are very kind and beautiful "
   Explain the procedures to convert the above sentence into Malayalam language using sequence to sequence model with attention mechanism. Is there any better method we can opt for? Analyse different methods you can adopt in this scenario and justify your better option.
2. You are developing a text mining application utilized for assisting organizations with finding their contacts, reports, business correspondence, emails, and so on. Which Text mining algorithm will be best suitable in your application? Justify.

Course Outcome 6 (CO6):

1. Implement an automatic question answering system for farmers.
2. Implement extractive summary preparation from medical reports.

Model Question Paper

QP CODE:

Reg No: _____

Name: _____ **PAGES : 4**

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

FIRST SEMESTER M.TECH DEGREE EXAMINATION, MONTH & YEAR

Course Code: 221ECS009

Course Name: NATURAL LANGUAGE PROCESSING AND TEXT MINING

Max. Marks : 60 **Duration: 2.5 Hours**

PART A

Answer All Questions. Each Question Carries 5 Marks

1. For each sentence, identify whether the different meanings arise from structural ambiguity, semantic ambiguity or pragmatic ambiguity? **(5)**

1. Time flies like an arrow

2. He crushed the key to my heart

2. The confusion matrix for a binary classifier is given below. Compute Precision, Recall, F- score, Specificity and Accuracy of the model **(5)**

Actual	Predicated	
	Class 1	Class 2
Class 1	14	2
Class 2	8	40

3. Justify whether a model/ program designed to perform sentimental analysis can be adapted for document grouping **(5)**

4. Describe the structure of GRU cell. How the output is computed at each gate? **(5)**

5. Produce the extractive summary by creating a document of your own with the title as “Kerala- at a glance”. Evaluate the performance of your summarizer by using the appropriate evaluation measures. **(5)**

Part B

(Answer any five questions. Each question carries 7 marks)

6. (a) Define minimum edit distance. **(2)**

(b) Compute the minimum edit distance between the strings INTENTION and EXECUTION using dynamic programming. **(5)**

7. (a) Consider a document collection having 37 documents **(5)**

Find the TF-IDF embedding of the following words, "Battle, Good, Fool, Wit" using the tables given below

Words	Document Frequency
Romeo	1
Salad	2
Falstaff	4
Forest	12
Battle	21
Wit	34
Fool	36
Good	37
Sweet	37

Raw Word Count	Doc1	Doc2	Doc3	Doc4
Battle	1	0	7	13
Good	114	80	62	89
Fool	36	58	1	4
Wit	20	15	2	3

(b) Find the cosine similarity off the words "Fool & Wit" **(2)**

8. Explain the Skip-gram and CBOW methods of word embedding generation. **(7)**

9. (a) Identify the Named Entities in the text given below and tag them with appropriate NE tags **(4)**

Citing high fuel prices, Indian Airlines said Friday it has increased by 56 per round trip on flights to some cities also served by lower-cost carriers. Spice Jet, a unit of AMR Corp, immediately matched the move, Spokesman Ram Goel said Indian Airlines, a unit of TATA Corp, said the increase took effect Thursday and applies to most routes where it competes against discount carriers, such as cochin to Delhi and Chennai to Calcutta.

(b) Why NE tagging is considered hard when compared to POS tagging? Give one method to overcome it. **(3)**

10. Describe the architecture of a RNN that can perform sequence classification. **(7)**

11. Explain in detail how LSTM can be used for language translation. **(7)**

12. (a) What application of text mining is coming under the Social Media Platform YouTube? Justify your answer. **(3)**

(b) Consider that you are running a business and you are having a social media page to promote your business. Is it possible to design a sentiment analyser by using the raw data extracted from the promotion page? Construct an architecture for the same. **(4)**

Syllabus

Module 1: Introduction

Natural Language Processing (NLP) - Syntax, semantics, pragmatics, and ambiguity in NLP, Regular Expressions, Text Normalisation, Edit Distance.

N-gram Language Models-N-Grams, Evaluating Language Models, Generalisation and Zeros, Smoothing, Kneser-Ney Smoothing, The Web and Stupid Backoff, Perplexity's Relation to Entropy.

Module 2: Neural Language Models, Vector Semantics and Embeddings

Neural Networks and Neural Language Models-Units, Feed-Forward Neural Networks, Training Neural Nets, Neural Language Models.

Vector Semantics and Embeddings-Lexical Semantics, Vector Semantics, Words and Vectors, Cosine for measuring similarity, TF-IDF: Weighing terms in the vector, Applications of the tf-idf vector model, Word2vec, Visualizing Embeddings, Semantic properties of embeddings, Bias and Embeddings, Evaluating Vector Models.

Module 3: Sentiment Classification and Part-of-Speech Tagging

Sentiment Classification –Sentiment classification. Machine Learning for Sentiment Classification - Training the Classifier (Naive Bayes, Logistic Regression, Support Vector Machine, Decision Tree, Random Forest), Optimising for Sentiment Analysis - Other text classification tasks – Evaluation of classification models: Precision, Recall, F-measure, Test sets and Cross-validation, Statistical Significance Testing.

Part-of-Speech Tagging-English Word Classes, The Penn Treebank Part-of-Speech Tagset, Part-of-Speech Tagging, HMM Part-of-Speech Tagging, Maximum Entropy Markov Models, Bi-directionality, Part-of Speech Tagging for Morphological Rich Languages. Information Extraction-Named Entity Recognition, Relation Extraction, Extracting Times, Extracting Events and their Times, Template Filling.

Module 4: Sequence Processing with Recurrent Networks

Sequence Processing with Recurrent Networks-Simple Recurrent Neural Networks, Applications of Recurrent Neural Networks, Deep Networks: Stacked and Bidirectional RNNs, Managing Context in RNNs: LSTMs and GRUs, Words, Subwords and Characters Neural Language Models and Generation Revisited, Encoder-Decoder Networks, Attention, Applications of Encoder-Decoder Networks. Case study: Machine translation, Question Answering

Module 5: Text Mining

Document representation - representing unstructured text documents with appropriate format and structure, automated text mining algorithms.

Text Mining: Text categorization, Text clustering, Topic modeling**,** Applications - classification, image annotation, collaborative filtering, and hierarchical topical structure modeling. Document summarization - Extraction- based summarization methods

Sentiment analysis - concept, sentiment polarity prediction, review mining, aspect identification. Text visualization - introduction to mathematical and programming tools.

Course Plan

No	Topic	No. of Lectures (40)
1	**Module 1: Introduction**	**6**
1.1	Natural Language Processing (NLP) - Syntax, semantics, pragmatics, and ambiguity in NLP	1
1.2	Regular Expressions	1
1.3	Text Normalisation, Edit Distance	1
1.4	N-gram Language Models-N-Grams, Evaluating Language Models	1
1.5	Generalisation and Zeros, Smoothing	1
1.6	Kneser-Ney Smoothing, The Web and Stupid Backoff, Perplexity's Relation to Entropy	1
2	**Module 2: Neural Language Models, Vector Semantics and Embeddings**	**8**
2.1	Units, Feed-Forward Neural Networks	1
2.2	Training Neural Nets	1
2.3	Neural Language Models	1
2.4	Lexical Semantics, Vector Semantics	1
2.5	Words and Vectors, Cosine for measuring similarity	1
2.6	TF-IDF: Weighing terms in the vector, Applications of the tf-idf vector model	1
2.7	Word2vec, Visualizing Embeddings	1

2.8	Semantic properties of embeddings, Bias and Embeddings, Evaluating Vector Models	1
3	**Module 3: Sentiment Classification and Part-of-Speech Tagging**	**10**
3.1	sentiment classification. Machine Learning for Sentiment Classification	1
3.2	Training the Classifier (Naive Bayes, Logistic Regression)	1
3.3	Training the Classifier (Support Vector Machine, Decision Tree, Random Forest)	1
3.4	Optimising for Sentiment Analysis - Other text classification tasks	1
3.5	Evaluation of classification models: Precision, Recall, F-measure, Test sets and Cross-validation, Statistical Significance Testing.	1
3.6	English Word Classes, The Penn Treebank Part-of-Speech Tagset	1
3.7	Part-of-Speech Tagging, HMM Part-of-Speech Tagging,	1
3.8	Maximum Entropy Markov Models, Bi-directionality, Part-of Speech Tagging for Morphological Rich Languages.	1
3.9	Information Extraction-Named Entity Recognition, Relation Extraction	1
3.10	Extracting Times, Extracting Events and their Times, Template Filling	1
4	**Module 4: Sequence Processing with Recurrent Networks**	**7**
4.1	Simple Recurrent Neural Networks, Applications of Recurrent Neural Networks	1
4.2	Deep Networks: Stacked and Bidirectional RNNs	1
4.3	Managing Context in RNNs: LSTMs	1
4.4	GRUs, Words, Subwords and Characters	1
4.5	Neural Language Models and Generation Revisited	1
4.6	Encoder-Decoder Networks, Attention, Applications of Encoder-Decoder Networks.	1
4.7	Case study: Machine translation, Question Answering	1
5	**Module 5: Text Mining**	**9**
5.1	Representing unstructured text documents with appropriate format and	1

	structure	
5.2	automated text mining algorithms	1
5.3	Text categorization	1
	Text clustering	1
5.5	Topic modelling, Applications - classification, imagine annotation, collaborative filtering, and hierarchical topical structure modeling	1
5.6	Document summarization - Extraction- based summarization methods	1
5.7	Sentiment analysis - concept, sentiment polarity prediction	1
5.8	Review mining, aspect identification.	1
5.9	Text visualization - introduction to mathematical and programming tools.	1

References

1. Daniel Jurafsky and James H. Martin. Speech and Language Processing (2nd ed), Pearson International edition, 2008
2. Manning C, Schuetze H. Foundations of Statistical Natural Language Processing, MIT Press, 1999
3. James Allen, "Natural Language Understanding", 2/E, Addison-Wesley, 1994
4. Charu C. Aggarwal and Cheng Xiang Zhai, “Mining Text Data”, Springer, 2012.
5. Text Mining Classification, Clustering, and Applications - Ashok N. Srivastava, Mehran Sahami, CRC Press.

221ECS010	ADVANCED COMPILER DESIGN	CATEGORY	L	T	P	CREDIT
		PROGRAM ELECTIVE 2	3	0	0	3

Preamble: This course enables the students to analyze the different phases of compiler / techniques for designing a compiler. This course introduces students to the advanced concepts of compilation phases such as lexical analysis, syntax analysis, semantic analysis, intermediate code generation, code optimization and code generation. This course helps the learners to design and develop compilers for programming languages.

Course Outcomes: After the completion of the course the student will be able to

CO 1	Illustrate lexical rules and grammars for a representative programming language **(Cognitive Level: Understand)**
CO 2	Construct intermediate code representations and code optimization techniques **(Cognitive Level: Apply)**
CO 3	Experiment with register allocation strategies and code scheduling **(Cognitive Level: Apply)**
CO 4	Inspect programming language design, target machine language design and run time environment of compilers**(Cognitive Level: Analyze)**
CO 5	Assess recent trends in compiler design and build a compiler for a hypothetical language**(Cognitive Level: Create)**

Program Outcomes (PO)

Outcomes are the attributes that are to be demonstrated by a graduate after completing the course.

PO1: An ability to independently carry out research/investigation and development work in engineering and allied streams

PO2: An ability to communicate effectively, write and present technical reports on complex engineering activities by interacting with the engineering fraternity and with society at large.

PO3: An ability to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program

PO4: An ability to apply stream knowledge to design or develop solutions for real world problems by following the standards

PO5: An ability to identify, select and apply appropriate techniques, resources and state-of-the-art tool to model, analyse and solve practical engineering problems.

PO6: An ability to engage in life-long learning for the design and development related to the stream related problems taking into consideration sustainability, societal, ethical and environmental aspects

PO7: An ability to develop cognitive load management skills related to project management and finance which focus on Entrepreneurship and Industry relevance.

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
CO 1	✓		✓	✓	✓	✓	
CO 2	✓		✓	✓	✓	✓	
CO 3	✓		✓	✓	✓	✓	
CO 4	✓		✓	✓	✓	✓	
CO 5	✓		✓	✓	✓	✓	✓

Assessment Pattern

Bloom's Category	End Semester Examination
Apply	70%-80%
Analyze	30%-40%
Evaluate	
Create	

Mark distribution

Total Marks	CIE	ESE	ESE Duration
100	40	60	2.5 hours

Continuous Internal Evaluation Pattern:

Evaluation shall only be based on application, analysis or design-based questions (for both internal and end semester examinations).

Continuous Internal Evaluation: 40 marks

i. Preparing a review article based on peer reviewed original publications (minimum 10 publications shall be referred) : 15 marks

ii. Course based task / Seminar/ Data collection and interpretation : 15 marks

iii. Test paper (1 number) : 10 marks

Test paper shall include minimum 80% of the syllabus.
Course based task/test paper questions shall be useful in the testing of knowledge, skills, comprehension, application, analysis, synthesis, evaluation and understanding of the students.

End Semester Examination Pattern:

The end semester examination will be conducted by the respective College.

There will be two parts; Part A and Part B.

Part A will contain 5 numerical/short answer questions with 1 question from each module, having 5 marks for each question. Students should answer all questions. Part B will contain 7 questions (such questions shall be useful in the testing of overall achievement and maturity of the students in a course, through long answer questions relating to theoretical/practical knowledge, derivations, problem solving and quantitative evaluation), with minimum one question from each module of which student should answer any five. Each question can carry 7 marks

Total duration of the examination will be 150 minutes.

Note: The marks obtained for the ESE for an elective course shall not exceed 20% over the average ESE mark % for the core courses. ESE marks awarded to a student for each elective course shall be normalized accordingly.

For example, if the average end semester mark % for a core course is 40, then the maximum eligible mark % for an elective course is 40+20 = 60 %.

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Explain context free grammar representation methods.

Course Outcome 2 (CO2):

1. Construct the translation of Boolean expressions into three-address code.

Course Outcome 3(CO3):

1. Build graph coloring global register allocator.

Course Outcome 4 (CO4):

1. Discover challenges in instruction level parallelism.

Course Outcome 5 (CO5):

1. Discuss loop optimization techniques in IBM XLCompilers.

Model Question Paper

QP CODE:

Reg No: _____

Name: _____ **PAGES: 2**

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

FIRST SEMESTER M.TECH DEGREE EXAMINATION, MONTH & YEAR

Course Code: 221ECS010

Course Name: ADVANCED COMPILER DESIGN

Max. Marks : 60 **Duration: 2.5 Hours**

PART A

Answer All Questions. Each Question Carries 5 Marks

1. Explain different implementation methods of Symbol table. **(5)**

2. With an example explain the following loop optimization techniques: **(5)**

a) Code motion.
b) Induction variable elimination and
c) Strength reduction

3. Explain graph colouring global register allocator. **(5)**

4. Explain reference counting garbage collector. **(5)**

5. Illustrate the role of peep hole optimization in the compilation process **(5)**

Part B

(Answer any five questions. Each question carries 7 marks)

6. Translate the following statements into three address statements and construct the flow graph. **(7)**

```
for(i=0;i<n;i++)

for(j=0;j<n;j++)

for(k=0;k<n;k++)

    C[i][j]=c[i][j]+a[i][k]*b[k][j]
```

7. Explain the translation of Boolean expressions into three-address code. **(7)**

8. Illustrate the liveness analysis on the flow graph with suitable example? **(7)**

9. Explain Dominators and Algorithm for finding Dominators. **(7)**

10. Explain static allocation and heap allocation strategies. Construct the Directed Acyclic Graph for the basic block given below and simplify the three-address code **(7)**

```
d = b *
ce=a+b
b =b *c
a = e –d
```

11. Illustrate loop invariant code motion with the following code segment. **(7)**

```
b= 2
i = 1
L1: if i>100 gotoL3
     a = b +1
     c =2
If i mode 2 == 0 goto L2
    d = c
     f= a + i
i = i + 1
goto  L1
L2: d = a + d
      e = i + d
L3 : end
```

12. Generate a code sequence for the assignment **d=(a-b)+(a-c)+(a-c).** Also define the use of algebraic identities in optimization of basic blocks? **(7)**

Syllabus

Module 1: Overview of Compiler Design

Introduction - The phases of Compiler - Lexical Analysis - Role of Lexical Analyzer - Specification and Recognition of Tokens - Context Free Grammar – Symbol - Table Structure, Symbol Attributes and Symbol - Table Entries, Local Symbol - Table Management, Global Symbol - Table Structure, Storage Binding and Symbolic Registers, Approaches to Generating Loads and Stores. Intermediate representation – Issues – High level, medium level, low level intermediate languages –MIR, HIR, LIR – ICANfor Intermediate code.

Module 2: Intermediate Representations

The value - number method for constructing DAGs - Addresses and instructions – Quadruples - Triples - Storage organization – Static versus dynamic storage allocation - stack allocation of space -Activation trees - Activation records - Garbage collection - Design goals for Garbage collectors -Reference counting garbage collectors - Introduction to trace - based collection - A basic mark - and-sweep collector. Translation of expressions Translation of expressions – Operations within expressions – Incremental translation – Addressing array elements – Translation of array references Control flow – Boolean expressions – Short - circuit code – flow – of - control statements – Control flow translation of Boolean expressions – Avoiding redundant Gotos – Boolean values and jumping code – Backpatching – One - passcode generation using back patching – Back patching for Boolean expressions – Flow- of-control statements – Break, continue and Goto statements Translation of switch statements – syntax directed translation of switch statements - intermediate code for procedures

Module 3: Code Optimization

Principal sources of optimization - causes of redundancy preserving transformations - Global common subexpressions - Copy Propagation - Dead code elimination – Code motion –Upward code motion – Downward code motion – Induction variables and reduction in strength -Introduction to data flow analysis - Loops in Flow graphs – Dominators - Introduction to global data flow analysis - Points and Paths - Reaching definitions - Live variable analysis - Data flow analysis of structured program.

Module 4: Register Allocation and Code Scheduling

Register allocation and assignment – graph coloring – control flow and low-level optimizations - Inter - procedural analysis and optimization – call graph — register allocation – global References: – Optimization for memory hierarchy. Code Scheduling – Instruction scheduling – peculative scheduling – Software pipelining – trace scheduling –percolation scheduling.

Module 5: Parallelism and Case study

Instruction - level parallelism - Instruction pipelines and branch delays – pipelined execution –data dependence – dependencies among memory accesses. Case Studies – Sun Compilers for SPARC–IBMXL Compilers – Alpha compilers – PA – RISC assembly language – COOL – (Classroom Object oriented language) – Compiler testing tools – SPIM

Course Plan

No	Topic	No. of Lectures (**40 Hours**)
1	**Module 1: Overview of Compiler Design**	**8**
1.1	Introduction - The phases of Compiler. Lexical Analysis – Role of Lexical Analyzer	1
1.2	Specification and Recognition of Tokens – Context Free Grammar	1
1.3	Symbol – Table Structure - Symbol Attributes and Symbol – Table Entries	1
1.4	Local Symbol – Table Management, Global Symbol – Table Structure,	1
1.5	Storage Binding and Symbolic Registers, Approaches to Generating Loads and Stores.	1
1.6	Intermediate representation – Issues	1
1.7	High level, medium level, low level intermediate languages	1
1.8	MIR, HIR, LIR – ICAN for Intermediate code.	1
2	**Module 2: Intermediate Representations**	**9**
2.1	The value – number method for constructing DAGs - Addresses and Instructions – Quadruples - Triples.	1
2.2	Storage organization – Static versus dynamic storage allocation - stack Allocation of space. Activation trees – Activation records.	1
2.3	Garbage collection – Design goals for Garbage collectors - Reference Counting garbage collectors. Introduction to trace – based collection - Abasic mark – and – sweep collector.	1

2.4	Translation of expressions Translation of expressions –Operations Within expressions–Incremental translation–Addressing array elements.	1
2.5	Translation of array references.	1
2.6	Control flow –Boolean expressions – Short – circuit code - flow- of - Control statements – Control flow translation of Boolean expressions.	1
2.7	Avoiding redundant Go to – Boolean values and jumping code.	1
2.8	Back patching - One-pass code generation using back patching – Backpatching for Boolean expressions.	1
2.9	Flow-of-control statements – Break, continue and Goto statements, Translation of switch statements – syntax directed translation of Switch statements - intermediate code for procedures.	1
3	**Module 3: Code Optimization**	**8**
3.1	Principal sources of optimization – causes of redundancy - Semantics Preserving transformations	1
3.2	Global common subexpressions – Copy Propagation – Dead code elimination.	1
3.3	Code motion – Upward code motion - Downward code motion.	1
3.4	Induction variables and reduction in strength.	1
3.5	Introduction to data flow analysis.	1
3.6	Loops in Flow graphs - Dominators	1
3.7	Introduction to global data flow analysis – Points and Paths - Reaching Definitions.	1
3.8	Live variable analysis-Data flow analysis of structured program	1
4	**Module 4: Register Allocation and Code Scheduling**	**7**
4.1	Register allocation and assignment – graph coloring .	1
4.2	Control flow and low-level optimizations.	1
4.3	Inter-procedural analysis and optimization.	1
4.4	Call graph—register allocation.	1
4.5	Global References: – Optimization for memory hierarchy.	1
4.6	Code Scheduling –Instructions scheduling – Speculative scheduling	1
4.7	Software pipelining. Trace scheduling – percolation scheduling	1

5	**Module 5: Parallelism and Case study**	**8**
5.1	Optimization of basic blocks.	1
5.2	The DAG representation of basic blocks.	1
5.3	Peep hole optimization.	1
5.4	Instruction- level parallelism-Instruction pipelines and branch Delays – pipelined execution.	1
5.5	Data dependence – dependencies among memory accesses.	1
5.6	Case Studies – Sun Compilers for SPARC.	1
5.7	IBMXL Compilers –Alpha compilers.	1
5.8	PA–RISC assembly language, COOL– (Classroom Object oriented language), Compiler testing tools –SPIM.	1

References

1. Steven S Muchnik, "Advanced Compiler Design and Implementation", Morgan Kaufmann publishers, Elsevier Science, India, Indian Reprint 2003.
2. Compilers: Principles, Techniques and Tools (2nd edition), Alfred V. Aho, Monica S. Lam, Ravi Sethi, and Jeffery D. Ullman., Addison Wesley, Boston, MA, 2006.
3. Compilers: Principles, Techniques and Tools, Aho, A. V, Sethi, R. and Ullman, J. D. Pearson Education, 1986.
4. D. M. Dhamdhere, "Compiler Construction" (2/e), Macmillan.
5. Cooper &Torczon, "Engineering a Compiler"Elsevier.
6. K C. Louden, "Compiler Construction: Principles and Practice"Cengage.

221ECS011	BIOINFORMATICS	CATEGORY	L	T	P	CREDIT
		PROGRAM ELECTIVE 2	3	0	0	3

Preamble: This course provides an exposure to the fundamental concepts and techniques in molecular biology and Bioinformatics. Accessing, retrieval and analysis of data from different types of biological databases are examined in this course. Sequence Alignment and Phylogenetic analysis helps to identify the relationship between species. Protein structure prediction and application of machine learning to bioinformatics is also discussed. This course helps the learners to identify computational problems in molecular biology and apply efficient algorithms to solve them.

Course Outcomes: After the completion of the course the student will be able to

CO 1	Make use of fundamental concepts of molecular biology to provide computational solutions **(Cognitive Knowledge Level: Understand)**
CO 2	Utilize bioinformatics tools and databases for retrieving, analysing and understanding biological data **(Cognitive Knowledge Level: Apply)**
CO 3	Analyze multiple sequences and find conserved regions. **(Cognitive Knowledge Level: Analyze)**
CO 4	Find the relationships between species by constructing phylogenetic tree. **(Cognitive Knowledge Level: Apply)**
CO 5	Predict unknown protein structures and apply concepts of Machine learning and their applications in Bioinformatics. **(Cognitive Knowledge Level: Apply)**
CO 6	Design, Develop, Implement and Present innovative ideas on Bioinformatics techniques. **(Cognitive Knowledge Level: Create)**

Program Outcomes (PO)

Outcomes are the attributes that are to be demonstrated by a graduate after completing the course.

PO1: An ability to independently carry out research/investigation and development work in engineering and allied streams

PO2: An ability to communicate effectively, write and present technical reports on complex engineering activities by interacting with the engineering fraternity and with society at large.

PO3: An ability to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program

PO4: An ability to apply stream knowledge to design or develop solutions for real world problems by following the standards

PO5: An ability to identify, select and apply appropriate techniques, resources and state-of-the-art tool to model, analyse and solve practical engineering problems.

PO6: An ability to engage in life-long learning for the design and development related to the stream related problems taking into consideration sustainability, societal, ethical and environmental aspects

PO7: An ability to develop cognitive load management skills related to project management and finance which focus on Entrepreneurship and Industry relevance.

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
CO 1	✓		✓	✓	✓	✓	
CO 2	✓		✓	✓	✓	✓	
CO 3	✓		✓	✓	✓	✓	
CO 4	✓		✓	✓	✓	✓	
CO 5	✓		✓	✓	✓	✓	
CO 6	✓	✓	✓	✓	✓	✓	✓

Assessment Pattern

Bloom's Category	End Semester Examination
Apply	70%-80%
Analyze	30%-40%
Evaluate	
Create	

Mark distribution

Total Marks	CIE	ESE	ESE Duration
100	40	60	2.5 hours

Continuous Internal Evaluation Pattern:

Evaluation shall only be based on application, analysis or design-based questions (for both internal and end semester examinations).

Continuous Internal Evaluation: 40 marks

i. Preparing a review article based on peer reviewed original publications (minimum 10 publications shall be referred) : 15 marks

ii. Course based task / Seminar/ Data collection and interpretation : 15 marks

iii. Test paper (1 number) : 10 marks

Test paper shall include minimum 80% of the syllabus.

Course based task/test paper questions shall be useful in the testing of knowledge, skills, comprehension, application, analysis, synthesis, evaluation and understanding of the students.

End Semester Examination Pattern:

The end semester examination will be conducted by the respective College.

There will be two parts; Part A and Part B.

Part A will contain 5 numerical/short answer questions with 1 question from each module, having 5 marks for each question. Students should answer all questions. Part B will contain 7 questions (such questions shall be useful in the testing of overall achievement and maturity of the students in a course, through long answer questions relating to theoretical/practical knowledge, derivations, problem solving and quantitative evaluation), with minimum one question from each module of which student should answer any five. Each question can carry 7 marks

Total duration of the examination will be 150 minutes.

Note: The marks obtained for the ESE for an elective course shall not exceed 20% over the average ESE mark % for the core courses. ESE marks awarded to a student for each elective course shall be normalized accordingly.

For example, if the average end semester mark % for a core course is 40, then the maximum eligible mark % for an elective course is 40+20 = 60 %.

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Explain the bio-sequences associated with central dogma of molecular biology.
2. Define translation. List two essential roles of ribosome during translation.

Course Outcome 2 (CO2)

1. Discuss the applications of Bioinformatics.
2. Examine the importance of primary biological databases.

Course Outcome 3(CO3):

1. Using Needleman and Wunsch dynamic programming method, construct the partial alignment score table for the following two sequences, using the following scoring parameters: match score: +5, mismatch score: -1, gap penalty: -2.

   GCATGCU

   GATTACA

   Write down the optimal global alignment between these sequences along with optimal score.

Course Outcome 4 (CO4):

1. Use UPGMA to reconstruct a phylogenetic tree using the following distance matrix.

Species	A	B	C	D
B	9	-	-	-
C	8	11	-	-
D	12	15	10	-
E	15	18	13	5

Course Outcome 5 (CO5):

1. Examine different algorithms for protein folding.
2. Elaborate Chou-Fasman and GOR methods for predicting secondary structure.

Course Outcome 6 (CO6):

1. Perform Phylogenetic Analysis on 2 gene Sequences.
2. Examine Microarrays and their applications in Bioinformatics.

Model Question Paper

QP CODE:

Reg No: _____

Name: _____ **PAGES:2**

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

FIRST SEMESTER M.TECH DEGREE EXAMINATION, MONTH & YEAR

Course Code: 221ECS011

Course Name: Bioinformatics

Max. Marks: 60 **Duration: 2.5 Hours**

PART A

Answer All Questions. Each Question Carries 5 Marks

1.	Explain the concept of base pairing. If the amount of thymine in genome is 30%, calculate the percentage of cytosine?	**(5)**
2.	Compare and contrast DDBJ, Genbank.	**(5)**
3.	Differentiate PAM and BLOSUM series.	**(5)**
4.	Differentiate between rooted and unrooted phylogenetic tees. How many rooted and unrooted trees are possible for n species?	**(5)**
5.	Explain the significance of protein folding.	**(5)**

Part B

(Answer any five questions. Each question carries 7 marks)

6.	(a)	If the sequence of one strand of DNA is written as follows: 5'-ATGCATGCATGCATGCATGCATGCATGC-3' Construct the sequence of complementary strand.	**(2)**
	(b)	With the help of a diagram explain the concept of central dogma of molecular Biology.	**(5)**
7.		Describe the importance of biological databases in bioinformatics. Explain Protein sequence databases.	**(7)**
8.		Define scoring matrices? Explain how PAM is derived?	**(7)**

9.	Using Smith Waterman method, construct the partial alignment scoring table and obtain the optimal local alignment of the following two sequences: _ ACGTATCGCGTATA GATGCTCTCGGAJAA	**(7)**
10.	Illustrate the concept of a phylogenetic tree? Explain the steps of UPGMA method for phylogenetic tree construction with an example.	**(7)**
11.	Explain the significance of Hidden Markov Model in bioinformatics. Discuss the advantages and disadvantages of using HMMs	**(7)**
12.	Explain any two methods for Protein Secondary Structure Prediction.	**(7)**

Syllabus

Module 1: Molecular Biology

Biomolecules-DNA, RNA and proteins-Components and structure. Genome organization. Letter codes for amino acids. Central dogma of molecular Biology. Genetic code. Interatomic forces in proteins, different levels of protein structure, protein domains, motifs.

Module 2: Bioinformatics

Definition and brief history. Bioinformatics vs Computational Biology. Scope and research areas of Bioinformatics. Data archives: Biological Databases-classification and importance; Nucleic acid databases: GenBank, DDBJ, EMB. Protein Sequence Databases: SwissProt, PIR. Derived databases: InterPro, Prosite, Pfam. Structure Databases: RCSB PDB, CATH, SCOP. Bibliographic Databases: PubMed, MEDLINE. Specialized databases. Gateways to archives: Entrez, SRS, ExPASy.

Module 3: Sequence Alignment

Concept of sequence alignment, Gaps in alignment, Scoring matrices: PAM and BLOSUM, Alignment of pairs of sequences: Dot Plot, Dynamic Programming, Alignment algorithms: The Needleman and Wunsch algorithm, Smith-Waterman algorithm. Search for homologous sequences using BLAST and FASTA programs. Statistical significance of database searches. Multiple sequence Alignment: Concept and Algorithms in MSA. Tools: Clustal, Mega.

Module 4: Molecular Phylogenetics

Concept and its relation to Multiple Sequence Alignment. Representation of phylogeny. Concept of Outgroup. Gene and Species phylogeny. Phylogenetic tree construction methods: Distance based and Character based. Phylogenetic software's: PHYLIP, MrBayes.

Module 5: Protein Structure Prediction and Advanced Bioinformatics

Protein Stability and folding, Ramachandran plot, Homology modelling, Energy minimization, CASP; Protein structure prediction software's: ESyPred3D, Rosetta; PSI-BLAST; Introduction to machine learning techniques: Hidden Markov models, Genetic algorithms and artificial neural networks. Applications of machine learning techniques in multiple sequence alignment, structure prediction and phylogenetic analysis

Course Plan

No	Topic	No. of Lectures (**40 Hours**)
1	**Module 1: Molecular Biology**	**5**
1.1	Biomolecules-DNA, RNA and proteins	1
1.2	Components and structure. Genome organization. Letter codes for amino acids.	1
1.3	Central dogma of molecular Biology	1
1.4	Genetic code. Interatomic forces in proteins	1
1.5	Different levels of protein structure, protein domains, motifs.	1
2	**Module 2: Bioinformatics**	**7**
2.1	Definition and brief history. Bioinformatics vs Computational Biology, Scope and research areas of Bioinformatics	1
2.2	Data archives: Biological Databases-classification and importance, Nucleic acid databases: GenBank, DDBJ, EMB	1
2.3	Protein Sequence Databases: SwissProt, PIR	1
2.4	Derived databases: InterPro, Prosite, Pfam	1
2.5	Structure Databases: RCSB PDB, CATH, SCOP	1
2.6	Bibliographic Databases: PubMed, MEDLINE	1
2.7	Specialized databases. Gateways to archives: Entrez, SRS, ExPASy.	1
3	**Module 3: Sequence Alignment**	**10**
3.1	Concept of sequence alignment, Gaps in alignment	1
3.2	Scoring matrices: PAM and BLOSUM	1
3.3	Alignment of pairs of sequences: Dot Plot, Dynamic Programming	1
3.4	Alignment algorithms: The Needleman and Wunsch algorithm	1

3.5	Smith-Waterman algorithm	1
3.6	Search for homologous sequences using BLAST and FASTA programs	1
3.7	Statistical significance of database searches	1
3.8	Multiple sequence Alignment: Concept	1
3.9	Algorithms in MSA	1
3.10	Tools: Clustal, Mega.	1
4	**Module 4: Molecular Phylogenetics**	**8**
4.1	Concept and its relation to Multiple Sequence Alignment	1
4.2	Representation of phylogeny	1
4.3	Concept of Outgroup	1
4.4	Gene and Species phylogeny	1
4.5	Phylogenetic tree construction methods: Distance based (Lecture 1)	1
4.6	Phylogenetic tree construction methods: Distance based (Lecture 2)	1
4.7	Phylogenetic tree construction methods: Character based	1
4.8	Phylogenetic software's: PHYLIP, MrBayes	1
5	**Module 5: Protein Structure Prediction and Advanced Bioinformatics**	**10**
5.1	Protein Stability and folding	1
5.2	Ramachandran plot, Homology modelling	1
5.3	Energy minimization	1
5.4	CASP; Protein structure prediction software's: ESyPred3D, Rosetta	1
5.5	PSI-BLAST	1
5.6	Introduction to machine learning techniques: Hidden Markov models	1
5.7	Genetic algorithms	1
5.8	Artificial neural networks	1
5.9	Applications of machine learning techniques in multiple sequence alignment	1
5.10	Structure prediction and phylogenetic analysis	1

References

1. Jin Xiong, Essential Bioinformatics, Cambridge University Press, 2006.
2. Brown T. A. Genomes 3, 3rd edition, BIOS Scientific Publishers Limited, 2007.

3. Jeremy M. Berg, John L. Tymoczko, Lubert Stryer, Biochemistry, 5th Edition, W. H. Freeman, 2002.
4. Arthur Lesk, Introduction to Bioinformatics, 5th Edition, Oxford University Press,2019.
5. Dan E. Krane, Fundamental concepts of Bioinformatics, 3rd Edition, Pearson Education India, 2002.
6. David W. Mount, Bioinformatics Sequence and Genome Analysis, 2nd Edition, Cold Spring Press, 2004.
7. Andreas D. Baxevanis, B. F. Francis Ouellette, Bioinformatics: A practical Guide to the Analysis of Genes and Proteins, John Wiley & Sons, 2004.
8. Dov Stekel, Microarray Bioinformatics, Cambridge University Press, 2003.

221LCS100	COMPUTING LAB 1	CATEGORY	L	T	P	Credit
		Laboratory 1	0	0	3	2

Preamble: Study of the course enables the learners to make use of the machine learning concepts and algorithms to derive data insights. The course provides exposure to the design and implementation aspects of machine learning algorithms such as decision trees, regression, naive bayes algorithm, clustering algorithms and artificial neural network. This helps the students to develop machine learning based solutions to real world problems.

Course Outcomes: After the completion of the course the student will be able to

CO#	Course Outcomes
CO1	Apply modern machine learning notions in predictive data analysis(**Cognitive Knowledge Level: Apply**)
CO2	Analyze the range of machine learning algorithms along with their strengths and weaknesses (**Cognitive Knowledge Level: Analyze**)
CO3	Design and develop appropriate machine learning models to solve real world problems. (**Cognitive Knowledge Level: Analyze**)
CO4	Build predictive models from data and analyze their performance(**Cognitive Knowledge Level: Create**)

Program Outcomes (PO)

Outcomes are the attributes that are to be demonstrated by a graduate after completing the course.

PO1: An ability to independently carry out research/investigation and developmentwork in engineering and allied streams

PO2: An ability to communicate effectively, write and present technical reports on complex engineering activities by interacting with the engineering fraternity and with society at large.

PO3: An ability to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program

PO4: An ability to apply stream knowledge to design or develop solutions for real world problems by following the standards

PO5: An ability to identify, select and apply appropriate techniques, resources and state-of-the-art tool to model, analyse and solve practical engineering problems.

PO6: An ability to engage in life-long learning for the design and development related to the stream related problems taking into consideration sustainability, societal, ethical and environmental aspects

PO7: An ability to develop cognitive load management skills related to project management and finance which focus on Entrepreneurship and Industry relevance.

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	✓	✓	✓	✓	✓	✓	
CO2	✓	✓	✓	✓	✓	✓	
CO3	✓	✓	✓	✓	✓	✓	
CO4	✓	✓	✓	✓	✓	✓	

Continuous Internal Evaluation Pattern:

The laboratory courses will be having only Continuous Internal Evaluation and carries 100 marks.

Final assessment shall be done by two examiners; one examiner will be a senior faculty from the same department.

Continuous Evaluation : 60 marks

Final internal assessment : 40 marks

Lab Report:

All the students attending the Lab should have a Fair Report. The report should contains details of experiment such as Objective, Algorithm/Design, Description, Implementation, Analysis, Results, and Outcome. The report should contain a print out of the respective code with inputs addressing all the aspects of the algorithm described and corresponding outputs. All the experiments noted in the fair report should be verified by the faculty regularly. The fair report, properly certified by the faculty, should be produced during the time of the final assessment.

Syllabus

Decision tree (ID3), Naïve bayesian classifier , Bayesian network, Expectation Maximization (EM) algorithm,K-means algorithm, K-nearest neighbor, Regression, Cross validation, Support Vector Machine (SVM), Artificial neural network, Backpropagation algorithm, Recurrent Neural Networks (RNN), Long Short Term Memory (LSTM), Google colab.

Practice Questions

1. Write a program to demonstrate the working of the decision tree based ID3 algorithm. Use an appropriate data set for building the decision tree and apply this knowledge to classify a new sample.
2. Write a program to implement the naïve bayesian classifier for a sample training data set stored as a .CSV file. Compute the accuracy of the classifier, considering few test data sets.
3. Assuming a set of documents that need to be classified, use the naïve bayesian Classifier model to perform this task. Calculate the accuracy, precision, and recall for your data set.
4. Write a program to construct a Bayesian network considering medical data. Use this model to demonstrate the diagnosis of heart patients using standard Heart Disease Data Set. You can use Python ML library classes/API.
5. Apply EM algorithm to cluster a set of data stored in a .CSV file. Use the same data set for clustering using k-Means algorithm. Compare the results of these two algorithms and comment on the quality of clustering. You can add Python ML library classes/API in the program.
6. Write a program to implement k-Nearest Neighbour algorithm to classify the iris data set. Print both correct and wrong predictions. Python ML library classes can be used for this problem.

7. Implement the non-parametric Locally Weighted Regression algorithm in order to fit data points. Select appropriate data set for your experiment and draw graphs.
8. Write a program to implement 5-fold cross validation on a given dataset. Compare the accuracy, precision, recall, and F-score for your data set for different folds.
9. Implement SVM/Softmax classifier for CIFAR-10 dataset: (i) using KNN, (ii) using 3 layer neural network.
10. Build an Artificial Neural Network by implementing the Backpropagation algorithm and test the same using appropriate data sets.
11. Image Captioning with Vanilla RNNs .
12. Image Captioning with LSTMs.
13. Familiarisation of cloud based computing like Google colab.

References:

1. Jiawei Han, Micheline Kamber, Jian Pei. Data Mining Concepts and Techniques, Third Edition. Morgan Kaufmann.
2. Christopher M. Bishop. Pattern recognition and machine learning. Springer 2006.
3. Ethem Alpaydin, Introduction to Machine Learning, 2nd edition, MIT Press 2010.
4. Mohammed J. Zaki and Wagner Meira, Data Mining and Analysis: Fundamental Concepts and Algorithms, Cambridge University Press, First South Asia edition, 2016.
5. Goodfellow, I., Bengio,Y., and Courville, A., Deep Learning, MIT Press, 2016.
6. Neural Networks and Deep Learning, Aggarwal, Charu C., c Springer International Publishing AG, part of Springer Nature 2018