SEMESTER I

Discipline: ELECTRONICS AND COMMUNICATION
Stream : EC3

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
221TEC100	ADVANCED ENGINEERING MATHEMATICS	DISCIPLINE CORE	3	0	0	3

Preamble: The purpose of this course is to expose students to the basic theory of linear algebra and probability.

Course Outcomes: The COs shown are only indicative. For each course, there can be 4 to 6 COs. After the completion of the course the student will be able to

CO 1	To analyze distributions of random variables and make computations based on that
CO 2	evaluate average behaviour of random variables, and analyze their converging behviours
CO 3	To analyze behaviour of random processes and explain basis of vector spaces.
CO 4	To evaluate properties of linear transformations
CO 5	To evaluate if a linear tranformaion is diagonalizable and decompose it using spectral decomposition theorem.

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO4	PO5	PO6	PO7
CO 1	3		3		3	3	
CO 2	3		3		3	3	
CO 3	3		3		3	3	
CO 4	3		3		3	3	
CO 5	3		3		3	3	

Assessment Pattern

Bloom's Category	End Semester Examination
Apply	20
Analyse	20
Evaluate	20
Create	

Mark distribution

Total Marks	CIE	ESE	ESE Duration
100	40	60	2.5 hours

Continuous Internal Evaluation Pattern:

Micro project/Course based project : 20marks
Course based task/Seminar/Quiz : 10marks
Test paper, 1 no. : 10 marks
The project shall be done individually. Group projects are not permitted. The project may include the implementation of theoretical computation using software packages.
The test papers hall include a minimum 80% of the syllabus.

End Semester Examination Pattern:

End Semester Examination: 60 marks

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 with minimum one question from each module of which student should answer any five. Each question can carry 7 marks.

Model Question Paper

A P J ABDUL KALAM TECHNOLOGICAL UNIVERSITY
M.TECH DEGREE EXAMINATION
SEMESTER:
Branch:
ADVANCED ENGINEERING MATHEMATICS

Time: 2.5 Hours **Marks: 60**

Part A

Answer ALL Questions. Each question carries 5 marks

1. Given that $ff(x) = \frac{k}{2^x}$ is a probability distribution of a random variable that can take on the values $x = 0,1,2,3,A\ 4$. Find k. Find the cumulative distribution function.
2. State and prove weak law of large numbers.
3. Show that $(1,3,2,-2), (4,1,-1,3), (1,1,2,0), (0,0,0,1)$ is a basis for R^4.
4. Let $T: V \rightarrow$ Wbe a linear transformation defined by $T(x,y,z) = (x+y, x-y, 2x+z)$. Find the range, null space, rank and nullity of T.
5. Describe an inner product space. If V is an inner product space, then for any vectors α, βin V prove that $\|\alpha+\beta\| \leq \|\alpha\| + \|\beta\|$.

Part B
Answer ANY FIVE Questions, one from each module
(5 x 7 marks = 35marks)

6. If the probability mass function of a RV X is given by $P(X = x) = kx^3, x = 1,2,3,4$. Find the value of k, $P\left(\frac{1}{2} < X < \frac{3}{2} / X > 1\right)$ mean and variance of X.
7. If the moment generating function of a uniform distribution for a random variable X is $\frac{1}{t}(e^{5t} - e^{4t})$.Find E(X).
8. Consider the Markov chain with three states, s={1,2,3} that has the following transition matrix $P = \begin{bmatrix} \frac{1}{2} & \frac{1}{4} & \frac{1}{4} \\ \frac{1}{3} & 0 & \frac{2}{3} \\ \frac{1}{2} & \frac{1}{2} & 0 \end{bmatrix}$ Draw the state diagram for the chain. If $P(X_1 = 1) = P(X_2 = 2) = \frac{1}{4}$, find $P(X_1 = 3, X_2 = 2, X_3 = 1)$.

9. Find the eigen values and eigen vectors of $A = \begin{bmatrix} 2 & 2 & 1 \\ 1 & 3 & 1 \\ 1 & 2 & 2 \end{bmatrix}$

10. Find the least square solution to the equation $Ax = b$, where $A = \begin{bmatrix} 1 & 2 \\ 1 & 3 \\ 0 & 0 \end{bmatrix}$ and $b = \begin{bmatrix} 4 \\ 5 \\ 6 \end{bmatrix}$. Obtain the projection matrix P which projects b on to the column space of A.
11. Let T be the linear transformation from R^3 to R^2 defined by T(x,y,z) =(x+y, 2z-x). Let B_1, B_2 be standard ordered bases of R^3 and R^2 respectively. Compute the matrix of T relative to the pair B_1, B_2.
12. Let V be a finite-dimensional complex inner product space, and let T be any linear operator on V. Show that there is an orthonormal basis for V in which the matrix of T is upper triangular.

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Syllabus

Module 1 Axiomatic definition of probability. Independence. Bayes' theorem and applications. Random variables. Cumulative distribution function, Probability Mass Function, Probability Density function, Conditional and Joint Distributions and densities, Independence of random variables. Functions of Random Variables: Two functions of two random variables. Pdf of functions of random variables using Jacobian.

Module 2 Expectation, Fundamental theorem of expectation, Moment generating functions, Characteristic function. Conditional expectation. Covariance matrix. Uncorrelated random variables. Pdf of Jointly Gaussian random variables, Markov and Chebyshev inequalities, Chernoff bound. Central Limit theorem. Convergence of random variables. Weak law of large numbers, Strong law of large numbers.

Module 3 Random Processes. Poisson Process, Wiener Process, Markov Process, Birth-Death Markov Chains, Chapman- Kolmogorov Equations,

Groups, Rings, homomorphism of rings. Field. Vector Space. Subspaces. direct sum. Linear independence, span. Basis. Dimension. Finite dimensional vector spaces. Coordinate representation of vectors. Row spaces and column spaces of matrices.

Module 4 Linear Transformations. Four fundamental subspaces of a linear transformation. Rank and Rank-nullity theorem. Matrix representation of linear transformation. Change of basis transformation. System of linear equations. Existence and uniqueness of solutions. Linear functionals. Dual, double dual and transpose of a linear transformation.

Module 5 Eigen values, Eigen vectors, Diagonizability.

Inner product. Norm. Projection. Least-squares solution. Cauchy-Schwartz inequality. Orthonormal bases. Orthogonal complement. Spectral decomposition theorem.

Course Plan

No	Topic	No. of Lectures
	Module I	
1.1	Axiomatic definition of probability. Independence. Bayes' theorem and applications.	2
1.2	Random variables. Cumulative distribution function, Probability Mass Function,	1
1.3	Probability Density function, Conditional and Joint Distributions and densities, Independence of random variables.	2
1.4	Functions of Random Variables: Two functions of two random variables. Pdf of functions of random variables using jacobian.	2
	Module II	
2.1	Expectation, Fundamental theorem of expectation, Conditional expectation.	1
2.2	Moment generating functions, Charectristic function.	1
2.3	Covariance matrix. Uncorrelated random variables. Pdf of Jointly Guassian random variables,	2
2.4	Markov and Chebyshev inequalities, Chernoff bound. Central Limit theorem.	2
2.5	Convergence of random variables. Weak law of large numbers, Strong law of large numbers.	2
3	**Module III**	
3.1	Random Processes. Poisson Process, Wiener Process,	2
3.2	Markov Process, Birth-Death Markov Chains, Chapman-Kolmogorov Equations,	2
3.3	Groups, Rings, homomorphism of rings. Field. Vector Space. Subspaces. direct sum.	2
3.4	Linear independence, span. Basis. Dimension. Finite dimensional vector spaces.	2
3.5	Coordinate representation of vectors. Rowspaces and column spaces of matrices.	1
4	**Module IV**	
4.1	Linear Transformations. Four fundamental subspaces of a linear transformation. Rank and Rank-nullity theorem.	2
4.2	Matrix representation of linear transformation. Change of basis transformation.	1
4.3	System of linear equations. Existence and uniqueness of solutions.	2
4.4	Linear functionals. Dual, double dual and transpose of a linear transformation.	2

5	**Module V**	
5.1	Eigen values, Eigen vectors, Diagonizability.	2
5.2	Inner product. Norm. Projection. Least-squares solution. Cauchy-Schwartz inequality.	2
5.3	Orthonormal bases. Orthogonal complement. Spectral decomposition theorem.	2

Reference Books

1. Hoffman Kenneth and Kunze Ray, Linear Algebra, Prentice Hall of India.

2. Jimmie Gilbert and Linda Gilbert, Linear Algebra and Matrix Theory, Elsevier

3. Henry Stark and John W. Woods "Probability and Random Processes withApplications to Signal Processing", Pearson Education, Third edition.

4. Athanasios Papoulis and S. Unnikrishna Pillai. Probability, Random Variables and Stochastic Processes, TMH

CODE	COURSE	CATEGORY	L	T	P	CREDIT
221TEC003	ADVANCED DIGITAL SIGNAL PROCESSING	PROGRAM CORE 1	3	0	0	3

Preamble: The course is intended to impart comprehensive knowledge in the domain of advanced digital signal processing

Prerequisite: Digital Signal Processing

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

CO 1	Assimilate the Non-parametric and parametric methods for spectral estimation
CO 2	Distinguish between forward and backward linear prediction
CO 3	List the utilities of adaptive filters
CO 4	Illustrate the use of Levinson Durbin algorithm for the solution of normal equations
CO 5	Compare and contrast LMS algorithm and RLS Algorithm for Adaptive Direct form FIR filters
CO 6	Develop the efficient realization of QMF filter bank using polyphase decomposition and multirate identities

Mapping of course outcomes with program outcomes

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

Assessment Pattern

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

Mark distribution

Total Marks	CIE	ESE	ESE Duration
100	40	60	2.5 hours

CORE COURSES

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.

End Semester Examination: 60 marks

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 (such questions shall be useful in the testing of knowledge, skills, comprehension, application, analysis, synthesis, evaluation and understanding of the students), with 1 question from each module, having 5 marks for each question. Students shall answer all questions. Part B contains 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 shall answer any five. Each question can carry 7 marks. Total duration of the examination will be 150 minutes.

Model Question Paper

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

M.TECH DEGREE EXAM

221TEC003 ADVANCED DIGITAL SIGNAL PROCESSING

TIME :2.5 HRS **MAX MARKS:60**

PART A

ANSWER ALL QUESTIONS(5*5=25)

1.Prove that the energy density spectrum of a deterministic signal can be obtained from the Fourier transform of that signal?

2.Differentiate between the MDL criterion and CAT criterion towards the selection of an AR Model order?

3.Use the Levinson Durbin algorithm to solve the normal equations recursively for an m-step forward predictor?

4.In adaptive filtering ,iterative schemes are preferred over linear estimations. Justify?

5.Obtain the frequency domain characterization of a sampling rate converter of a rational factor 2 /3 ?

PART B

ANSWER ANY FIVE.EACH QUESTION CARRIES 7 MARKS(7*5=35)

6.With necessary equations ,substantiate the use of the Welch method-Averaging Modified Periodogram for spectrum estimation?

7.Ilustrate, the performance characteristics & Computational requirements of non-parametric methods for spectral estimation?

8.With necessary equations, explain the Yule-Walker method for AR model parameters in the context of parametric spectral estimation?

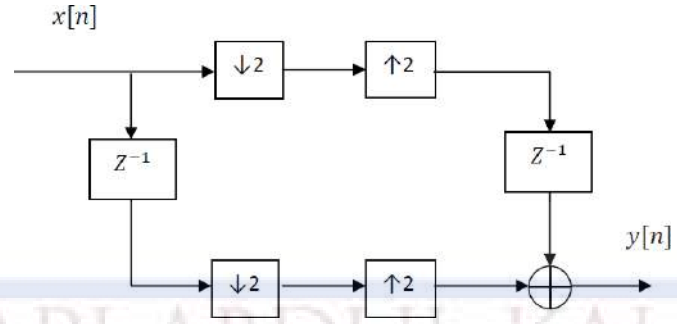
9.Illustrate how Schur Algorithm can be utilized for the Solution of the Normal Equations?

10.Describe an adaptive equalizer using RLS algorithm?

11.What is the PR condition for a filterbank? Design the analysis filter bank for a perfect reconstruction two channel Quadrature Mirror filterbank?

12.a.Realize a 3 band FIR filter of length N=15 using polyphase decomposition?

b.Express the output y[n] of the multirate system given below, as a function of the input x[n].



Syllabus and Course Plan(For 3 credit courses, the content can be for 40 hrs and for 2 credit courses, the content can be for 26 hrs)

Syllabus

Power spectrum estimation, Non-parametric methods for spectral estimation: Parametric spectral estimation, Linear Prediction and optimum linear filters, Adaptive filters for adaptive channel equalization,adaptive noise cancellation, Adaptive Direct form FIR filters: Multirate Signal Processing, The Polyphase decomposition-Applications to sub band coding, Fourier transform,Short-time(windowed) Fourier transform. The discrete wavelet transform.

Course Plan

No	Topic	No. of Lectures
1	**Power spectrum estimation**	
1.1	Estimation of spectra from finite duration observation of signals: Computation of Energy density spectrum-Estimation of the Autocorrelation and power spectrum of random signals -The periodogram,Use of DFT in power spectrum estimation -	2
1.2	Non-parametric methods for spectral estimation: Barlett method-Averaging Periodogram, Welch method-Averaging Modified Periodogram	3
1.3	Blackman and Tukey Method-Performance characteristics & Computational requirements of non-parametric methods for spectral estimation:	3
2	**Parametric spectral estimation**	
2.1	Parametric spectral estimation: Relationship between Autocorrelation and Model parameters	2
2.2	Yule-Walker method for AR model parameters, Burg method for AR model parameters	3
2.3	Selection of AR model order- MA and ARMA models for power spectrum estimation	4
3	**Linear Prediction and optimum linear filters**	

3.1	Linear Prediction : Forward and Backward Linear Prediction Optimum reflection coefficients for the Lattice Forward and Backward Predictors.	3
3.2	Solution of the Normal Equations: Levinson Durbin Algorithm, Schur Algorithm	3
3.3	Properties of Linear Prediction Filters	2
4	**Adaptive filters**	
4.1	Adaptive filters for adaptive channel equalization,adaptive noise cancellation and Linear Predictive Coding of Speech Signals	3
4.2	Adaptive Direct form FIR filters:Minimum mean square criteria,LMS algorithm	2
4.3	Adaptive Direct form filters:The RLS algorithm,Fast RLS Algorithm,Properties of Direct Form RLS algorithm	3
5	**Multirate Signal Processing**	
5.1	Mathematical description of sampling rate converters- Interpolator and Decimator,Multirate Identities	2
5.2	The Polyphase decomposition-Applications to sub band coding - Two Channel QMF filer bank-PR condition.	3
5.3	Fourier transform,Short-time(windowed) Fourier transform,The discrete wavelet transform-Wavelet- admissibility condition.MRA Axioms,scaling and wavelet function	3

Text books:

1. John G. Proakis, Dimitris G. Manolakis, “Digital Signal Processing”, Pearson Education,India, 2007

2. Monson H. Hayes, “Statistical Digital Signal Processing and Modeling”, John Wiley and Sons Inc., New York, 2006.

3. P. Vaidyanathan, “Multirate Systems and Filter Banks”, Pearson Education

References:

1. Simon Haykin, “Adaptive Filter Theory”, Prentice Hall, Englewood Cliffs, NJ1986.
2.Steven M Kay,” Modern spectrum Estimation theory and application”, Pearson India,January 2009
3.D.G. Manolakis, V.K. Ingle and S.M. Kogon: Statistical and Adaptive Signal Processing, McGraw Hill, 2000
4.Sophoncles J. Orfanidis, “Optimum Signal Processing “, McGraw-Hill, 2000
5. S K Mitra,”Digital Signal Processing: A computer based approach”, Tata-McGraw Hill
4. C S Burrus, R A Gopinath, H. Guo, “Introduction to Wavelets and Wavelet Transforms: A primer”, Prentice Hall.

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
221TEC004	TOPICS IN MACHINE LEARNING	PROGRAM CORE 2	3	0	0	3

Preamble: Machine learning is a subfield of artificial intelligence, which is broadly defined as the capability of a machine to imitate intelligent human behavior. Artificial intelligence systems are used to perform complex tasks in a way that is similar to how humans solve problems. Machine learning allows software applications to become more accurate at predicting outcomes without being explicitly programmed to do so. Machine learning algorithms use historical data as input to predict new output values. Students will be able to learn machine learning fundamentals, understand the different types of algorithms in machine learning, develop in-depth knowledge of machine learning tasks such as regression, classification, clustering etc.

Prerequisite: A sound knowledge of the fundamentals and basics of probabilty, statistics and algorithms.

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

CO 1	Understand and apply the fundamentals, concepts and terminologies in machine learning, Deep learning and artificial intelligence.
CO 2	Understand and analyse the principles of supervised and unsupervised learning and illustrate the functionalities of the supervised and unsupervised learning algorithms.
CO 3	Understand and analyse the principles of semi-supervised and reinforcement learning and illustrate the functionalities of the semi-supervised and reinforcement learning learning algorithms.
CO 4	Analyze and evaluate the performance of artificial neural networks and deep learning neural architectures.
CO 5	Create and evaluate critically the domain specific applications of Machine learning.

Mapping of course outcomes with program outcomes

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

Bloom's Category	End Semester Examination %
Apply	10
Analyse	40
Evaluate	30
Create	20

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.

End Semester Examination: 60 marks

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 (such questions shall be useful in the testing of knowledge, skills, comprehension, application, analysis, synthesis, evaluation and understanding of the students), with 1 question from each module, having 5 marks for each question. Students shall answer all questions. Part B contains 7 questions (such questions shall be useful in the testing of overall achievement and maturity of the students in a course, through long answer question relating to theoretical/practical knowledge, derivations, problem solving and quantitative evaluation), with minimum one question from each module of which student shall answer any five. Each question can carry 7 marks. Total duration of the examination will be 150 minutes.

Model Question Paper

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

FIRST SEMESTER M.TECH DEGREE EXAMINATION, (**Model Question Paper)**

Discipline: ELECTRONICS & COMMUNICATION

ENGINEERING

Stream: EC3 (Signal Processing, Signal Processing

& Embedded Systems, Communication

Engineering & Signal Processing)

Course Code: 221TEC004

Course Name: TOPICS IN MACHINE LEARNING

Max. Marks: 60 Duration: 2.5Hours

PART A

Answer ALL Questions. Each Question Carries 5 marks.

1	A sample x1, ..., xn has been obtained from a probability model specified by mass or density function $f_X(x; \theta)$ depending on parameter(s) θ lying in parameter space Θ. Estimate the maximum likelihood.	CO1	
2	Illustrate with an example, the k- nearest neighbour algorithm for pattern classification. How do you compute the distance between two patterns ?	CO2	
3	Explain how semi-supervised learning is different from supervised learning. Illustrate self learning.	CO2	
4	Demonstrate gradient descent algorithm for error back propagation in ANNs.	CO2	
5	Suggest a strategy based on machine learning techniques for sentiment analysis in social networks. Explain with neat schematics.	CO3	

PART – B

Answer any 5 full questions ; each question carries 7 marks.

6. a)	With neat schematics, explain machine learning process flow. Explain the process involved in model building and validation, interpretaion of model and data visualization.	5	CO4	

6. b)	What do you mean by hyperparameters ? Explain the process of fine tuning the hyper parameters.	2	CO3	
7.a)	Discuss the principles of density based clustering and explain the basic algorithm. What do you mean by ε -neighbourhood ?	3	CO1	
7. b)	With the help of relevant equation explain how do you compute cosine similarity between two feature vectors.	4	CO5	
8.a)	State the dual problem of optimization for SVM for linearly non-separable patterns. Obtain the equation of optimal hyperplane and optimum weight vectors wo and optimum bias bo for linearly non-separable patterns. Give expression for finding the label of a test example xt.	2	CO2	
8.b)	Explain what do you mean by hard and soft margins. Derive the expression for the margin of separation for SVM.	5	CO4	
9. a)	Explain the concept of error back propagation learning used in MLFFNN. Obtain the weight updation equation for MLFFNN with one hidden layer.	3	CO4	
9.b)	Discuss the significance of activation functions. With the help of a neat sketch explain sigmoidal activation function. Explain how spread factor (β) value is selected	3	CO1	
9.c)	Discuss the functionalities of different layers in a CNN.	1	CO2	
10.a)	Compare and contrast between agglomerative and divisive techniques for clustering. Give the step-by-step algorithm for agglomerative clustering. What are the proximity measures between clusters ?	2	CO1	
10.b)	With the help of suitable illustrations explain the selection of number of clusters using silhouette analysis.	5	CO3	
11.a)	Discuss the basic concepts of deep learning. With a neat schematic explain the principles of convolutional neural networks.	3	CO1	
11.b)	Discuss the need for pooling layer in a CNN architecture. Distinguish between max pooling and average pooling.	4	CO3	
12.a)	Illustrate the use of machine learning algorithms in medical image segmentation for brain tumor detection. Draw neat schematics for the system and expalin the functionality of each module.	3	CO5	
12.b)	Explain the use of machine learning algorithms and tools for rain forecasting in Kerala. Explain the data collection process, data refinement and models used for prediction. How do you validate the model?	4	CO5	

Module - 1 (Basics of Machine Learning)

Introduction to machine learning, artificial intelligence and deeplearning. Learning algorithms - over fitting and under fitting, hyperparameters and validation sets, estimators, bias and variance, Maximum Likelihood Estimation. Machine learning process flow- define problem, objective, data acquisition and preprocessing, feature engineering, model building and validation.

Module -2 (Supervised and Unsupervised Learning)

Supervised Learning- Basic principles of linear regression, logistic regression. Classification- Supervised algorithms-Decision trees, k-Nearest Neighbour, Naive Bayes, support vector machines, ensemble learning techniques. Unsupervised Learning- Basic principles of clustering, clustering algorithms-hierarchical algorithms-agglomerative, divisive algorithms. Partitioning algorithms- k-means, k medoids algorithms, density based algoritms.

Module -3 (Semi-supervised and Reinforcement Learning)

Semi-supervised learning – Types of semi-supervised learning- Self learning, graph based SSL-label propagation. Reinforcement Learning-Taxonomy, Reinforcement Learning Algorithms-Value based, Policy based and model based algorithms. Characteristics and types of reinforcement learning. Reinforcement learning models- Markov decision process, Q-learning.

Module -4 (Artificial Neural Networks and Deep Learning)

Artificial neural networks- Basic principles of Back propagation, Gradient Descent, Training Neural Network, Initialisation and actvation functions. Deep learning principles and achitectures-Dropout, Batch normalisation, Ensemble learning, Data augmentation, Transfer learning, Convolutional Neural Networks, Recurrent Neural Networks, LSTM, Data augmentation-GAN.

Module- 5 (Applications of Machine Learning)

Machine learning applications for prediction-weather, sales of a store, eligibility of loan. Medical diagnoses, Financial industry and trading, image classification, recognition and segmentation, speech recognition, automatic language translation and auto corrections, recommendation engines.

Course Plan

No	Topic	No. of Lectures [40Hrs]
1	**Basics of machine learning.**	
1.1	Introduction to machine learning.	1
1.2	Artificial intelligence and deeplearning.	1
1.3	Learning algorithms-over fitting and under fitting, hyperparameters and validation sets.	2
1.4	Estimators, bias and variance, Maximum Likelihood Estimation.	1
	Machine learning process flow- define problem, objective, data acquisition and preprocessing, feature engineering, model building and validation.	2
2	**Semi-supervised and Reinforcement Learning**	
2.1	Supervised Learning- Basic principles of linear regression, logistic regression.	2
2.2	Classification-Supervised algorithms-Decision trees, k-Nearest Neighbour, Naive Bayes.	2
2.3	Support vector machines, ensemble learning techniques.	2
2.4	Unsupervised Learning- Basic principles of clustering.	1
2.5	Clustering algorithms-hierarchical algorithms-agglomerative, divisive algorithms. Partitioning algorithms- k-means, k medoids algorithms, density based algoritms.	2
2.6	Partitioning algorithms- k-means, k medoids algorithms, density based algoritms. Case study in clustering- Medical image segmentation.	2
3	**Semi-supervised and Reinforcement Learning**	
3.1	Semi-supervised learning – Types of semi-supervised learning-Self learning, graph based SSL-label propagation.	2
3.2	Reinforcement Learning-Taxonomy, Reinforcement Learning Algorithms-Value based, Policy based and model based algorithms. Characteristics and types of reinforcement learning. Reinforcement learning models- Markov decision process, Q-learning.	3
3.3	Characteristics and types of reinforcement learning. Reinforcement learning models- Markov decision process, Q-learning.	3
4	**Artificial Neural Networks and Deep Learning**	

4.1	Artificial neural networks- Basic principles of Back propagation, Gradient Descent.	2
4.2	Training Neural Network, Initialisation and actvation functions.	ICATION-EC3
4.3	Deep learning principles and achitectures-Dropout, Batch normalisation, Ensemble learning, Data augmentation, Transferlearning.	2
4.4	Convolutional Neural Networks, Recurrent Neural Networks, LSTM, Data augmentation-GAN.	3
5	**Applications of Machine Learning**	
5.1	Machine learning applications for prediction-weather, sales of a store, eligibility of loan.	2
5.2	Medical diagnoses, Financial industry and trading.	2
5.3	Image recognition, classification and segmentation.	1
5.4	Speech recognition, automatic language translation and auto corrections, recommendation engines.	2

Text Books

1. Machine Learning: The Art and Science of Algorithms that Make Sense of Data, Peter A Flach, Cambridge University Press, ISBN-10 1107422221, 2012.

2. Applied Machine Learning, 2nd Edition, M. Gopal, Mc Graw Hill Education, ISBN-10 : 9789353160258, 2018.

3. Neural Networks and Learning Machines, Simon S. Haykin, 3rd Edition, Pearson-Prectice Hall, ISBN-10: 0-13-147139-2, 2009.

Reference Books

1. An Introduction to Machine Learning, Miroslov Kubat, Springer, ISBN-10 3030819345, 2021.

2. Machine Learning, 1st Edition, Saika Dutt, Subramanian Chandramouli, Amit Kumar Das, Pearson Education, ISBN-10 9353066697, 2018.

3. Machine Learning: A First Course for Engineers and Scientists, Andreas Lindholm, Niklas Wahlstom, Fredrik Lindsten et al., Cambridge University Press, ISBN-10 1108843603, 2022.

4. Handbook of Reinforcement Learning and Control, Kyriakos G. Vamvoudakis, Yan Wan, et al., ISBN-10 3030609898, Sprimger, 2021.

5. Neural Networks and Deep Learning, Charu C. Aggarwal, Springer, ISBN: 978-3-319-94463-0, 2018.

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
221LEC001	SIGNAL PROCESSING LAB 1	LABORATORY 1	0	0	2	1

Preamble: To experiment the concepts introduced in the topics : Linear Algebra, Random processes, Advanced Signal Processing and Machine Learning

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

CO 1	Apply knowledge of Linear algebra, Random processes,Advanced Signal Processing and Machine Learning in various signal processing applications.
CO 2	Develop the student's ability on analysing observations of experiments/ simulations, interpreting them and preparing reports
CO 3	Apply the fundamental principles of linear algebra and random processes
CO 4	Familiarize the basic operations of filter banks through simulations
CO 5	Implement the basic algorithms learned in Machine learning
CO 6	Implement a mini project pertaining to an application of Signal Processing in real life

Assessment Pattern

Bloom's Category	CIE
Apply	40
Analyse	30
Evaluate	15
Create	15

Mark distribution

Total Marks	CIE	ESE
100	100	--

Continuous Internal Evaluation Pattern:

Tools :

Numerical Computing Environment – MATLAB or any other equivalent tool.

Syllabus

No	Topics
1	**Linear Algebra**
1.1	Row Reduced Echelon Form: To reduce the given mxn matrix into Row reduced Echelon form
1.2	Gram-Schmidt Orthogonalization: To find orthogonal basis vectors for the given set of vectors. Also find orthonormal basis.
1.3	Least SquaresFit to a Sinusoidal function
1.4	Least Squares fit to a quadratic polynomial
1.5	Eigen Value Decomposition
1.6	Singular Value Decomposition
1.7	Karhunen- Loeve Transform
2	**Advanced DSP**
2.1	Sampling rate conversion: To implement Down sampler and Up sampler and study their characteristics
2.2	Two channel Quadrature Mirror Filterbank: Design and implement a two channel Quadrature Mirror Filterbank
3	**Random Processes**
3.1	To generate random variables having the following probability distributions (a) Bernoulli(b) Binomial(c) Geometric(d) Poisson(e)Uniform,(f) Gaussian(g)Exponential (h) Laplacian
3.2	Central Limit Theorem: To verify the sum of sufficiently large number of Uniformly distributed random variables is approximately Gaussian distributed and to estimate the probability density function of the random variable.
4	**Machine Learning**
4.1	Implementation of K Nearest Neighbours Algorithm with decision region plots
4.2	Implementation of K Means Algorithm with decision region plots
4.3	Implementation of Perceptron Learning Algorithms with decision region plots
4.4	Implementation of SVM algorithmfor classification applications
5	**Implement a mini project pertaining to an application of Signal Processing in real life, make a presentation and submit a report**

SEMESTER I

PROGRAM ELECTIVE I

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
221EEC012	ADVANCED DIGITAL COMMUNICATION	PROGRAM ELECTIVE 1	3	0	0	3

Preamble: Digital communications is a broad term that incorporates all procedures and forms of transmission of data or information. This course imparts mathematical modelling about various modulation schemes, channels and multipath mitigation techniques.

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

CO 1	Represent digitally modulated signals in signal space.
CO 2	Design of Optimum receiver for AWGN channel.
CO 3	Design of Equalizers for optimum detection in presence of ISI
CO 4	Analyse Multi Channel and Multi Carrier Systems
CO 5	Evaluate Digital Communication through Fading Multipath Channels
CO 6	Analysis of CDMA systems

Mapping of course outcomes with program outcomes

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

Assessment Pattern

Bloom's Category	End Semester Examination %
Apply	20
Analyse	50
Evaluate	30
Create	

Mark distribution

Total Marks	CIE	ESE	ESE Duration
100	40	60	2.5 Hrs

Evaluation of Elective Courses

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

Continuous Internal Evaluation: 40 marks

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

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

Test paper, 1 no. : 10 marks

Test paper shall include minimum 80% of the syllabus.

End Semester Examination: 60 marks

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 (such questions shall be useful in the testing of knowledge, skills, comprehension, application, analysis, synthesis, evaluation and understanding of the students). 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.

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 %.

Model Question Paper

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

M.TECH DEGREE EXAMINATION

First Semester

Branch:

ADVANCED DIGITAL COMMUNICATION

Time: 2.5 Hours **Marks: 60**

Part A

Answer ALL Questions. Each question carries 5 marks

1. Represent 8-PSK as a linear combination of two orthonormal signal waveforms. Using Gray encoding label the corresponding signal points
2. Derive the impulse response of a matched filter.
3. Explain Nyquist criteria for zero ISI. Illustrate the pulse shape for zero ISI.
4. Design a 4 bit PN sequence generator with shift registers.
5. Explain RAKE receiver.

Part B

Answer ANY FIVE Questions. Each question carries 7 marks

6. Three messages are transmitted over an AWGN channel with noise power spectral density $N_0/2$ The messages are

$$S1(t) = \begin{cases} 1\ ;\ 0 \le t \le T \\ 0\ ;\ other\ wwwse \end{cases}$$

$$S_2(t) = -S_3(t) = \begin{cases} 1\ ;\ 0 \le t \le T/2 \\ -1;\ \frac{T}{2} \le t \le T \\ 0;\ otherwwwse \end{cases}$$

   i. Find the dimensionality of the signal space.
   ii. Find and draw an appropriate basis for the signal space.
7. Derive the expression for error probability of binary QPSK modulation scheme in AWGN channel.
8. In an un-equalized linear filter channel the noise free output of the demodulator when a '1' is transmitted is

$$x_m = \begin{cases} 0.3; & m = 1 \\ 0.9; & m = 0 \\ 0.3; & m = -1 \\ 0 & otherwise \end{cases}$$

   Design a three tap zero forcing equalizer so that the output is $q_m = \begin{cases} 1; & m = 0 \\ 0; & m = \pm 1 \end{cases}$
9. Explain an FFT based multi-carrier System.

10. Explain the Delay locked loop for tracking DS spread spectrum signal.
11. A multipath fading channel has a multipath spread of Tm=1 sec and a Doppler spread Bd = 0.01 Hz. The total channel bandwidth at band-pass available for signal transmission is W=5 Hz. To reduce ISI the selected pulse duration is T= 10 sec.
    (i)Determine the coherence Bandwidth and Coherence Time?
    (ii)Is the channel is frequency selective?
12. Explain the ALOHA system and protocols in multiuser communication system.

Syllabus

Module I

Characterization of Communication Signals and Systems: Overview of Digital Communication systems,Communication Channels and Mathematical models,Representation of band pass signals and systems, Signal spacerepresentation,Representation of digitally modulated signals, Spectral Characteristics of Digitally Modulated Signals.

Module II

Optimum receiver for AWGN channel:Correlationdemodulator, matched filter demodulator, optimum detector,Performance of optimum receiver for memoryless modulationtechniques, Probability of error for binary modulation and M-ary orthogonal signals, Probability of errorQPSK, QAM.

Module III

Communication through Band-Limited Linear Filter channelsOptimum receiver for channels with ISI andAWGN,Equalization techniques: Linear equalization, Decisionfeedback equalization,Adaptive equalization Algorithms(ZF and LMS).

Module IV

Multi Channel and Multi Carrier Systems: Multichannel Digital communication in AWGN channels,Multicarrier communication- Discrete implementation of multicarrier modulation. FFT based multi carrier system,Spread spectrum principles, Generation of PN sequences, DSSS & FHSS, Synchronization of Spread Spectrum signals.

Module V

Digital Communication through Fading Multipath Channels: Characterisation of fading multipath channel,Frequency-nonselective slowly fading channel, Diversity techniques,Digital signalling over a frequencyselectiveslowly fading channel, RAKE receiver,Multiple access techniques- CDMA signal and channel models.

Course Plan

ELECTRONICS AND COMMUNICATION-EC3

No	Topic	No. of Lectures
1	**Characterization of Communication Signals and Systems:**	
1.1	Overview of Digital Communication systems.	1
1.2	Communication Channels and Mathematical models	2
1.3	Representation of band pass signals and systems, Signal spacerepresentation.	2
1.4	Representation of digitally modulated signals	2
1.5	Spectral Characteristics of Digitally Modulated Signals.	2
2	**Optimum receiver for AWGN channel:**	
2.1	Correlationdemodulator, matched filter demodulator, optimum detector.	3
2.2	Performance of optimum receiver for memoryless modulationtechniques: probability of error for binary modulation and M-aryorthogonal signals	3
2.3	Probability of errorQPSK, QAM.	2
3	**Communication through Band-Limited Linear Filter channels**	
3.1	Optimum receiver for channels with ISI and AWGN.	3
3.2	Equalization techniques: Linear equalization, Decision feedback equalization,	3
3.3	Adaptive equalization: Algorithms(ZF and LMS)	2
4	**Multi Channel and Multi Carrier Systems**	
4.1	Multichannel Digital communication in AWGN channels	2
4.2	Multicarrier communication: Discrete implementation of multicarrier modulation. FFT based multi carrier system	2
4.3	Spread spectrum principles, Generation of PN sequences,	2
4.4	Direct sequence spread spectrum (DSSS), Frequency Hopping SpreadSpectrum (FHSS), Synchronization of Spread Spectrum signals.	3
5	**Digital Communication through Fading Multipath Channels**	
5.1	Characterisation of fading multipath channel	1
5.2	Frequency-nonselective slowly fading channel	2
5.3	Diversity techniques for Fading Multipath channels	2
5.4	Digital signalling over a frequencyselectiveslowly fading channel. RAKE receiver	2
5.5	Multiple access techniques- CDMA signal and channel models, Random access Methods	3

Text Books

1. John G.Proakis, Digital Communications, 4/e, McGraw-Hill

Reference Books

1. Edward. A. Lee and David. G. Messerschmitt, “Digital Communication”, Allied Publishers (second edition).
2. Viterbi, A. J., and J. K. Omura. Principles of Digital Communication and Coding. NY: McGraw-Hill, 1979. ISBN: 0070675163.
3. Marvin K Simon, Sami M Hinedi, William C Lindsey - Digital Communication - Techniques –Signal Design & Detection, PHI.
4. Bernard Sklar,” Digital Communications: Fundamentals and applications “, Prentice Hall 2001.
5. Andrea Goldsmith,” Wireless Communications”, Cambridge University Press 2005.

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
221EEC013	PATTERN ANALYSIS	PROGRAM ELECTIVE 1	3	0	0	3

Preamble: Pattern analysis is the use of machine learning algorithms to identify and categorise patterns. It classifies data based on statistical information or knowledge gained from patterns and their representation. The popular pattern analysis tasks are pattern recognition, classification, clustering and retrival. Students will be able to learn pattern analysis fundamentals, understand the different types of algorithms in pattern analysis, develop in-depth knowledge of pattern analysis tasks such as classification, clustering, matching, retrieval etc.

Prerequisite: A sound knowledge of the fundamentals and basics of probabilty, statistics and algorithms.

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

CO 1	Understand and apply the fundamentals, concepts and terminologies in pattern analysis.
CO 2	Understand and analyse the principles of feature extraction and optimization and illustrate the functionalities of the feature extraction and optimization algorithms.
CO 3	Understand and analyse the principles of supervised models for pattern analysis and illustrate the functionalities of the supervised pattern analysis algorithms.
CO 4	Understand and analyse the principles of unsupervised models for pattern analysis and illustrate the functionalities of the unsupervised pattern analysis algorithms.
CO 5	Create and evaluate critically the domain specific applications of pattern analysis.

Mapping of course outcomes with program outcomes

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

Assessment Pattern

Bloom's Category	End Semester Examination
Apply	20 %
Analyse	40 %
Evaluate	20 %
Create	20 %

Mark distribution

Total Marks	CIE	ESE	ESE Duration
100	40	60	2.5 hours

Continuous Internal Evaluation: 40 marks

Preparing a review article based on peer reviewed

Original publications (minimum 10 Publications shall be referred): 15 marks

Course based task/Seminar/Data Collection and interpretation: 15 marks

Test paper, 1 no.: 10 marks

Test paper shall include minimum 80% of the syllabus. include minimum 80% of the syllabus.

End Semester Examination: 60 marks

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 (such questions shall be useful in the testing of knowledge, skills, comprehension, application, analysis, synthesis, evaluation and understanding of the students). 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.

Note: The marks obtained for the ESE for an elective course shall not exceed 20% 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 %.

Model Question paper

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

FIRST SEMESTER M. TECH DEGREE EXAMINATION, (**Model Question Paper)**

Discipline: ELECTRONICS & COMMUNICATION ENGINEERING

Stream: EC3 (Signal Processing, Signal Processing

& Embedded Systems, Communication

Engineering & Signal Processing)

Course Code: 221EEC013

Course Name: PATTERN ANALYSIS

Max. Marks: 60 Duration: 2.5Hours

PART A

Answer ALL Questions. Each Question Carries 5 marks.

1	Explain the concept of discriminant functions. Derive the discriminant function for a two class classification problem. Assume patterns are drawn from normal distribution	CO1	
2	Demonstrate dimensionality reduction of feature vectors using Fisher score based method.	CO2	
3	Illustrate with an example, the k- nearest neighbour algorithm for pattern classification. How do you compute the distance between two patterns ?	CO2	
4	With a suitable example demostrate the k-means clustering algorithm. Discuss the significance of silhoutte score to select optimal k.	CO2	
5	What do you mean by out lier detection? Explain an experimental set up for outlier detection from banking transaction data.	CO3	

PART – B

Answer any 5 full questions ; Each question carries 7 marks.

6. a)	The minimum error rate classification can be achieved by the use of discriminant functions gi(x) = ln p(x|wi) + ln P(wi). The densities p(x|wi) are assumed to be multivariate Gaussian. Determine the discriminant function for (i) Σi = σ^2*I (ii) Σi = Σ and Σi = arbitrary. Discuss the nature of decision surface in each case.	5	CO4	

6. b)	Illustrate the working of LDA with a suitable toy dataset. Also explain how predictions are made.	2	CO3	
7.a)	Explain Bayes decision theory. Give expression for Bayes decision rule. Discuss the significance.	3	CO1	
7. b)	Give the expresion for Bayesian decision function. Use Bayes decision rule to find the answer to the following problem: Suppose a drug test is 99% sensitive and 99% specific. That is, the test will produce 99% true positive results for drug users and 99% true negative results for non-drug users. Suppose that 0.5% of people are users of the drug. If a randomly selected individual tests positive, what is the probability that they are a user?	4	CO5	
8.a)	Compare and contrast between the use of DFT and DCT for extracting transform based features from image data.	2	CO2	
8.b)	Discuss the significance of dimensionality reduction. Explain step-by step algorithm for PCA	5	CO4	
9. a)	Discuss gradient descent algorithm used in MLFFNN. Also comment on local and global minimum	3	CO4	
9.b)	Explain the concept of error back propagation learning used in MLFFNN. Obtain the weight updation equation for MLFFNN with one hidden layer.	3	CO1	
9.c)	Compare MLFFNN and perceptron based classifiers for pattern analysis. Comment on the stopping criterion for both.	1	CO2	
10.a)	Explain what do you mean by hard and soft margins. Derive the expression for the margin of separation for SVM.	2	CO1	
10.b)	State the dual problem of optimization for SVM for linearly non-separable patterns. Obtain the equation of optimal hyperplane and optimum weight vectors wo and optimum bias bo for linearly non-separable patterns. Give expression for finding the label of a test example xt.	5	CO3	
11.a)	Discuss the principles of fuzzy of k-means clustering	3	CO1	
11.b)	Illustrate hierarchical clustering for text classification of English sentences. Clearly explain the methodology used for generating feature vectors from sentences, similarity measures selected, formation of similarity matrix and formation of clusters. Also discuss the termination criteria.	4	CO3	
12.a)	List at least 3 pattern analysis tasks that we frequently encounter in our real world life.	3	CO5	

12.b)	Illustrate the functionality of Music Information Retrieval system with neat sketches. Design a MIR system. Explain the functionality of each module.	4	CO5	

Syllabus

Module - 1 (Introduction to Pattern Analysis) : Introduction - features, feature vectors and classifiers, Supervised versus unsupervised pattern recognition. Classifiers based on Bayes Decision theory- Review of Probability Theory, Conditional Probability and Bayes rule. Bayesian classification for normal distributions, Bayes classifier, Case I, Case II and Case III. Linear classifiers- Linear and quadratic discriminant functions and decision hyper planes.

Module -2 (Feature extraction and optimization)

Review of Linear Algebra. Linear Transformations-KLT, SVD, ICA, DFT, DCT, DST, Hadamard Transform, Wavelet Transform and transform based features. Feature engineering- Feature extraction- Global and local features, features for shape and characterization, typical features for object recognition in images, typical features for speech and audio classification, Feature reduction and optimization- Dimensionality reduction techniques, Principal component analysis**.**

Module 3 (Supervised Models for Pattern Classification)

K-Nearest-Neighbor Classification, selection criterion for k. The perceptron learning algorithm, classifier using perceptron. Multi layer perceptrons- Multilayer feed forward neural networks, Training neural networks, back propagation, gradient descent algorithm, activation functions and performance analysis of MLFFNN. Introduction to CNN. Support vector machines- SVM for linearly separable and nonlinearly separable patterns. Concept of maximum margin, kernels for SVM, kernel trick.

Module -4 (Unsupervised Models for pattern Classification)

Clustering - Vector Quantization, k-means clustering, Silhouette score, Cluster analysis, Proximity measures, Clustering Algorithms - Sequential algorithms, Hierarchical algorithms - Agglomerative algorithms, Divisive algorithms. Clustering Schemes - based on function optimization -Fuzzy clustering algorithms, Probabilistic clustering, Clustering algorithms based on graph theory.

Module- 5 (Applications of Pattern Analysis)

Application of pattern analysis in image classification, speech recognition, speaker identification, multimedia document recognition (MDR), automatic medical diagnosis. Outlier detection, novelty/anomaly detection using pattern analysis. Music and image/video retrieval systems.

Course Plan

No	Topic	No. of Lectures [40Hrs]
1	**Introduction to Pattern Analysis**	
1.1	Introduction - features, feature vectors and classifiers, Supervised versus unsupervised pattern recognition.	2
1.2	Classifiers based on Bayes Decision theory- Review of Probability Theory, Conditional Probability and Bayes rule.	2
1.3	Bayesian classification for normal distributions, Bayes classifier, Case I, Case II and Case III.	3
1.4	Linear classifiers- Linear and quadratic discriminant functions and decision hyper planes.	2
2	**Feature extraction and optimization**	
2.1	Review of Linear Algebra. Linear Transformations-KLT, SVD, ICA, DFT, DCT, DST, Hadamard Transform, Wavelet Transform and transform based features.	2
2.2	Feature engineering- Feature extraction- Global and local features, features for shape and characterization.	3
2.3	Typical features for object recognition in images, typical features for speech and audio classification.	2
2.4	Feature reduction and optimization- Dimensionality reduction techniques.	3
2.5	Principal component analysis.	2
3	**Supervised Models for Pattern Classification**	
3.1	K-Nearest-Neighbor Classification, selection criterion for k. The perceptron learning algorithm, classifier using perceptron.	3
3.2	Multi layer perceptrons- Multilayer feed forward neural networks, Training neural networks, back propagation, gradient descent algorithm, activation functions and performance analysis of MLFFNN. Introduction to CNN.	
3.3	Support vector machines- SVM for linearly separable and nonlinearly separable patterns. Concept of maximum margin, kernels for SVM, kernel trick.	3
4	**Unsupervised Models for pattern Classification**	
4.1	Clustering - Vector Quantization, K-means clustering, Silhouette score.	3
4.2	Cluster analysis, Proximity measures, Clustering Algorithms - Sequential algorithms, Hierarchical algorithms - Agglomerative	

	algorithms, Divisive algorithms.	
4.3	Clustering Schemes based on function optimization-Fuzzy clustering algorithms, Probabilistic clustering,	2
4.4	Clustering algorithms based on graph theory.	3
5	**Applications of Pattern Analysis**	
5.1	Application of pattern analysis in image classification, speech recognition, speaker identification.	2
5.2	Multimedia document recognition (MDR), automatic medical diagnosis.	2
5.3	Outlier detection, novelty/anomaly detection using pattern analysis.	1
5.4	Music and image/video retrieval systems.	2

Text Books

1. Pattern classification , Richard O. Duda and Hart P.E, and David G Stork, , 2nd Edn., John Wiley & Sons Inc., 2001

2. Neural Networks and Learning Machines, Simon S. Haykin, 3rd Edition, Pearson-Prectice Hall, ISBN-10: 0-13-147139-2, 2009.

3. Pattern Recognition, Sergios Theodoridis, Konstantinos Koutroumbas , Academic Press, 2006.

Reference Books

1. Pattern Recognition and Classification- An Introduction, Geoff Dougherty, ISBN: 978-1-4614-5323-9, Springer, 2013.

2. Advances in Fuzzy Clustering and its Applications, Jose Valente de Olliveira (Editor), Witold Pedrycz (Editor), ISBN: 978-0-470-02760-8, Wiley 2017.

3. Digital Pattern Recognition, King Sun Fu, ISBN: 978-3-642-96303-2, Springer, 1976

4. Pattern Recognition and Image Analysis Earl Gose, Richard Johnsonbaugh, and Steve Jost,, PHI Pvt. Ltd., NewDelhi-1, 1999.

5. Statistical Pattern Recognition, 2nd Edition, Andrew R. Webb, ISBN:9780470845134, John Wiley & Sons, 2002

CODE	COURSE	CATEGORY	L	T	P	CREDIT
221EEC014	SPEECH SIGNAL PROCESSING	PROGRAM ELECTIVE 1	3	0	0	3

Preamble: This course aims to develop in-depth understanding of fundamentals of speech analysis, parametric representations and models of speech and speech processing applications enabling the students to explore into research and development of speech processing systems.

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

CO 1	Understand the basic concepts of speech production and apply time domain analysis methods for classification of speech sounds
CO 2	Analyse speech segments using frequency domain techniques - STFT and Cepstral analysis
CO 3	Apply LPC Analysis to speech signals
CO 4	Analyse and apply speech coding techniques for speech compression, storage and transmission
CO 5	Understand the fundamentals of speech processing applications

Mapping of course outcomes with program outcomes

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

Assessment Pattern

Bloom's Category	End Semester Examination
Apply	40%
Analyse	40%
Evaluate	20%
Create	

Mark distribution

Total Marks	CIE	ESE	ESE Duration
100	40	60	2.5 hours

Continuous Internal Evaluation Pattern:

Preparing a review article based on peer reviewed
Original publications (minimum10 Publications shall be referred):**15 marks**

Course based task/Seminar/Data Collection and interpretation: **15 marks**

Test paper (Shall include minimum of 80% of the syllabus)1 no.: **10 marks**

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 (such questions shall be useful in the testing of knowledge, skills, comprehension, application, analysis, synthesis, evaluation and understanding of the students). 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.

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 %.

Model Question Paper

No. of Pages: 2

ELECTRONICS AND COMMUNICATION-EC3 **D**

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

FIRST SEMESTER M. TECH DEGREE EXAMINATION

Branch: Electronics and Communication Engineering

Stream(s): Signal Processing

Course Code & Name: ***221EEC014 - SPEECH SIGNAL PROCESSING***

Max. Marks: 60 Duration: 2.5 hours

PART A

Answer all questions. Each question carries 5 marks.

1. How do you differentiate voiced and unvoiced speech segments using short time zero crossing rate and short time energy?
2. Why do we do short time analysis in the case of speech signals? Distinguish between narrow band and wide band spectrograms.
3. Explore the use of AR models in the analysis of speech signals.
4. How is perceptual irrelevancy removal used in speech compression?
5. Investigate the challenges in speech segmentation?

PART B

Answer any five questions. Each question carries 7 marks.

6. The waveforms and autocorrelation plots of two phonemes segmented from continuous speech are given in Fig.1(a) and Fig.1(b). Analyze the figures and state your inferences.

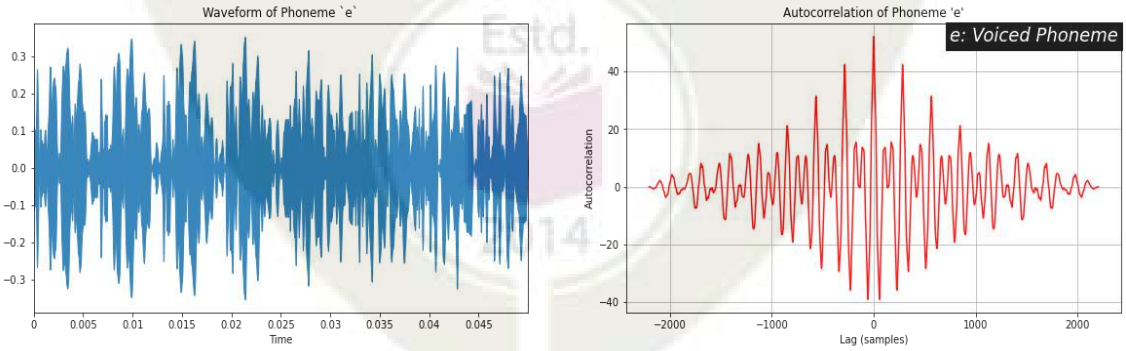


Fig.1(a)

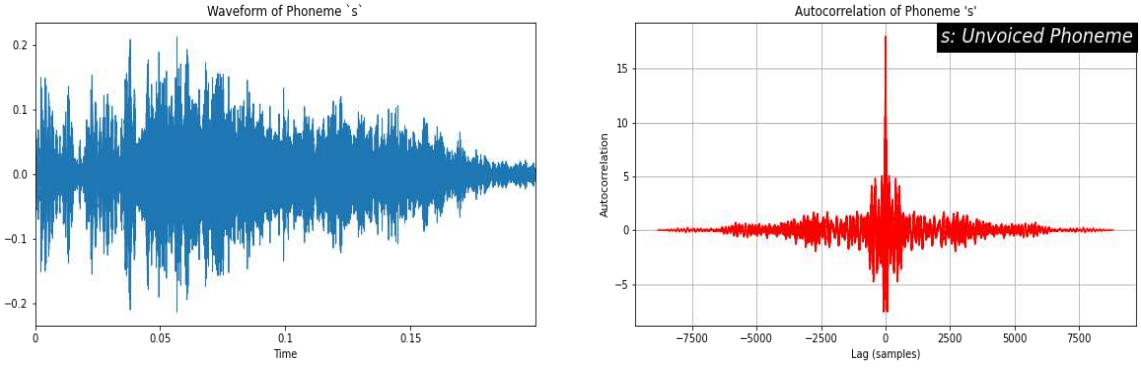


Fig.1(b)

7. How can we use cepstral analysis to separate source and filter characteristics of a speech signal? Derive the steps involved in obtaining cepstral coefficients.
8. Formulate the Filter Bank Summation (FBS) method of STFT synthesis. Derive the FBS constraint.
9. How can we use Levinson Durbin algorithm to find the LPC coefficients?
10. How can we use sub band coding for speech compression?
11. How can we convert any given text to speech ?
12. How can we automatically verify the identity of a given speaker?
13.

Syllabus

MODULE I

Speech Production and Short-Time Speech Analysis:Acoustic theory of speech production, Excitation, Vocal tract model for speech analysis, Formant structure, Pitch, Articulatory Phonetics, and Acoustic Phonetics, Time domain analysis (Short time energy, short time zero crossing Rate, ACF),

MODULE II

Frequency domain analysis: Filter Banks, STFT, Spectrogram, Formant Estimation & Analysis, Cepstral Analysis, MFCC,

MODULE III

Parametric representation of speech: AR model, ARMA model, LPC model, Autocorrelation method, Covariance method, Levinson-Durbin Algorithm, Lattice form, Sinusoidal Model, GMM, Hidden Markov Model,

MODULE IV

Speech coding: Phase Vocoder, LPC, Sub-band coding, Adaptive Transform Coding, Harmonic Coding, Vector Quantization based Coders, CELP

MODULE V

Applications of speech processing: Fundamentals of Speech recognition, Speech segmentation, Text-to-speech conversion, speech enhancement, Speaker Verification, Language Identification

Course Plan

No	Topic	No. of Lectures
1	**MODULE I**	
1.1	Acoustic theory of speech production, Excitation, Vocal tract model for speech analysis	2
1.2	Formant structure, Pitch, Articulatory Phonetics, and Acoustic Phonetics	2
1.3	Time domain analysis (Short time energy, short time zero crossing Rate, ACF).	2
2	**MODULE II**	
2.1	Filter Banks, STFT	3
2.2	Spectrogram, Formant Estimation & Analysis	2
2.3	Cepstral Analysis, MFCC	2
3	**MODULE III**	
3.1	AR model, ARMA model, LPC Analysis - LPC model, Autocorrelation method	3
3.2	Covariance method, Levinson-Durbin Algorithm, Lattice form	3
3.3	Sinusoidal Model, GMM, Hidden Markov Model	3
4	**MODULE IV**	
4.1	Phase Vocoder, LPC, Sub-band coding	3
4.2	Adaptive Transform Coding, Harmonic Coding	3
4.3	Vector Quantization based Coders, CELP	3
5	**MODULE V**	
5.1	Fundamentals of Speech recognition, Speech segmentation.	3
5.2	Text-to-speech conversion, speech enhancement	3
5.3	Speaker Verification, Language Identification	3

Reference Books

1. Thomas F. Quatieri, Discrete-Time Speech Signal Processing: Principles and Practice, Prentice Hall; ISBN: 013242942X; 1st edition
2. Rabiner and Juang, Fundamentals of Speech Recognition, Prentice Hall, ISBN: 0130151572.
3. Douglas O'Shaughnessy, Speech Communications: Human & Machine, IEEE Press, Hardcover 2nd edition, 1999; ISBN: 0780334493.
4. Digital Processing of Speech Signals, 1st edition, ISBN: 97881317051314.

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
221EEC015	ADVANCED EMBEDDED PROCESSORS	PROGRAM ELECTIVE 1	3	0	0	3

Preamble: This course is intended to impart thorough knowledge in embedded processors. It also helps to develop skills in designing complex systems using different processor architectures.

Course Prerequisites: Basic knowledge in digital electronics and Microprocessors at UG level.

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

CO 1	Understand the basics of an embedded system
CO 2	Familiarize ARM Architecture
CO 3	Understand and analyse the structure and design of an Embedded System
CO 4	Analyse Product Enclosure, Design and Development
CO 5	Compare standard I/O interfaces.
CO 6	Design an Embedded System

Mapping of course outcomes with program outcomes

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

Assessment Pattern

Bloom's Category	End Semester Examination
Apply	20%
Analyse	50%
Evaluate	
Create	30%

Mark distribution

Total Marks	CIE	ESE	ESE Duration
100	40	60	2.5 hours

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

Continuous Internal Evaluation Pattern:

Continuous Internal Evaluation: 40 marks

Preparing a review article based on peer reviewed original publications (minimum 10 publications shall be referred)	15 marks
Course based task/Seminar/Data collection and interpretation	15 marks
Test paper, 1 no. (Test paper shall include minimum 80% of the syllabus.)	10 marks
TOTAL	**40 marks**

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 (such questions shall be useful in the testing of knowledge, skills, comprehension, application, analysis, synthesis, evaluation and understanding of the students). 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.

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 %.

Model Question Paper

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

FIRST SEMESTER M. TECH DEGREE EXAMINATION

Program: M.Tech.in EC3 (Signal Processing, Signal Processing & Embedded Systems, Communication Engineering & Signal Processing)

Course Code: 221EEC015

Course Name: ADVANCED EMBEDDED PROCESSORS

Max. Marks: 60 Duration: 150 Minutes

Part A

Answer All Questions. Each Carries 5 mark.

1. Mention two application of embedded system in health care and how can it be used for monitoring purpose.
2. Discuss about some of the deviation of ARM architecture from pure RISC nature.
3. Explain the linear waterfall model of EDLC.
4. Discuss any two product enclosure development techniques
5. What is cross compilation? What are the files generated on cross compilation?

Part B

Answer any five questions: Each question carries 7 marks.

6. With a neat diagram explain the parts or elements of an embedded system.
7. Explain the 5-stage pipeline ARM organization with the help of a neat diagram.
8. Discuss the different phases of EDLC with the help of classic Embedded Product Development Life Cycle Model
9. Discuss and describe the communication interfacing technique used in USB and IEEE 1394.
10. Explain the external communication interfaces in detail.
11. Describe the boundary scan technique for testing the interconnection among the various chips in a complex hardware board.
12. Explain the SPI bus architecture with the help of a neat bus architecture diagram

Syllabus

Module 1: 8 hours

Introduction to Embedded systems: Embedded system examples, Parts of Embedded System, Typical Processor architecture, Power supply, clock, memory interface, interrupt, I/O ports, Buffers, Programmable Devices, ASIC, etc. Simple interfacing examples, Memory Technologies, EPROM, Flash, OTP, SRAM, DRAM, SDRAM etc

Module 2: 11 hours

ARM architecture: ARM organization and Implementation, Memory Hierarchy, ARM Instruction Set and Thumb Instruction set.High- Level Language Programming, System Development using ARM. Digital Signal Processing on ARM, Peripheral Programming and system design for a specific ARM processor (ARM7/9).

Module 3: 7 hours

Embedded System product Development: Embedded System product Development Life cycle (EDLC). Specifications, Component selection, Schematic Design, PCB layout, fabrication and assembly.

Module 4: 6 hours

Product enclosure design and development: Concept of firmware, operating system and application programs. Power supply Design, External Interfaces.

Module 5: 8 hours

Embedded System Development Environment: IDE, Cross compilation, Simulators/Emulators. Hardware Debugging. Hardware testing methods like Boundary Scan, In Circuit Testing (ICT) etc., Serial EEPROM, PWM, Analog to digital converter Bus architecture like I2 C, SPI, AMBA, CAN etc.

COURSE PLAN

No	Topic	No. of Lectures
1	**Introduction to Embedded systems**	
1.1	Embedded system examples, Parts of Embedded System, Typical Processor architecture, Power supply, clock, memory interface, interrupt, I/O ports, Buffers, Programmable Devices, ASIC, etc	4
1.2	Simple interfacing examples, Memory Technologies, EPROM, Flash, OTP, SRAM, DRAM, SDRAM etc	4
2	**ARM architecture**	
2.1	ARM organization and Implementation, Memory Hierarchy, ARM Instruction Set and Thumb Instruction set	4
2.2	High- Level Language Programming, System Development using ARM	4
2.3	Digital Signal Processing on ARM, Peripheral Programming and system design for a specific ARM processor (ARM7/9).	3
3	**Embedded System product Development**	
3.1	Embedded System product Development Life cycle (EDLC)	3
3.2	Specifications, Component selection, Schematic Design, PCB layout, fabrication and assembly.	4
4	**Product enclosure design and development**	
4.1	Concept of firmware, operating system and application programs	3
4.2	Power supply Design, External Interfaces.	3
5	**Embedded System Development Environment**	
5.1	IDE, Cross compilation, Simulators/Emulators	3
5.2	Hardware Debugging. Hardware testing methods like Boundary Scan, In Circuit Testing (ICT) etc.,	2
5.3	Serial EEPROM, PWM, Analog to digital converter, Bus architecture like I2C, SPI, UART, AMBA, CAN etc.	3

Text Books

1. Shibu K.V. Introduction to Embedded Systems, Tata McGraw Hill, 2009.
2. Steve Furber, ARM System-on-chip Architecture, Second Edition Pearson Education, 2007.

Reference Books

1. Van Ess, Currie and Doboli, Laboratory Manual for Introduction to Mixed-Signal, Embedded Design, Alphagraphics, USA
2. William Hohl, ARM Assembly Language Programming, CRC Press, 2009.
3. Andrew Sloss, Dominic Symes, Christ Wright, ARM System Developer's guide – Designing and optimizing software, Elsevier Publishers, 2008.

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
221EEC016	INFORMATION HIDING AND DATA ENCRYPTION	PROGRAM ELECTIVE 1	3	0	0	3

Preamble: The course is designed to provide an insight to various data encryption and information hiding techniques and applying these techniques in various security applications. The course also aims to develop skills in analysing the strengths and weakness of various techniques used for information security.

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

CO 1	Apply various techniques for data encryption and analyse the performance (K3).
CO 2	Identify and apply information hiding and digital watermarking techniques for given problems in security systems (K3).
CO 3	Analyse publications related to encryption and information hiding in journals and conferences and submit report (K4).
CO 4	Choose and solve a research problem in the area of data encryption /and information hiding (K5).

Mapping of course outcomes with program outcomes

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

Assessment Pattern

Bloom's Category	End Semester Examination	Continuous Internal Evaluation
Understand	10	
Apply	40	10
Analyse	10	15
Evaluate		15
Create		

Mark distribution

Total Marks	CIE	ESE	ESE Duration
100	40	60	2.5 hours

Continuous Internal Evaluation Pattern:

Preparing a review article based on peer reviewed original publications (minimum 10 Publications shall be referred):	15 marks
Course based task/Seminar/Data Collection and interpretation:	15 marks
Test paper, 1 no.: (Test paper shall include minimum 80% of the syllabus.)	10 marks

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 (such questions shall be useful in the testing of knowledge, skills, comprehension, application, analysis, synthesis, evaluation and understanding of the students). 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.

CO level Assessment Questions

CO1: Apply various techniques for data encryption and analyse the performance

1. Distinguish between a synchronous and a nonsynchronous stream cipher.
2. In the DSS scheme, if Eve can find the value of r (random secret), can she forge a message? Explain.
3. Prove that $(x^3 + x^2 + 1)$ is an irreducible polynomial of degree 3.

CO2: Identify and apply information hiding and digital watermarking techniques for given problems in secure communication systems

1. Choose a digital watermarking technique for protecting an image and justify
2. Derive a method to hide an image in a video with optimal bandwidth.
3. Describe the hiding techniques in spatial and temporal transform domains and their applications.

CO3: Analyse publications related to encryption and information hiding in journals and conferences and submit report.

1. Review any 10 conference papers on digital watermarking techniques, analyse and prepare a report.
2. Analyse at least 10 journal papers on video steganography and present.

CO4: Choose and solve a research problem in the area of data encryption /and information hiding.

1. Encrypt any text data using symmetric and asymmetric methods of encryption and compare the performance.
2. Protect an audio file which has to be protected and transmitted through a vulnerable and noisy channel using image steganography.
3. Hide an image using any one of the conventional steganographic techniques and also using network steganography (Protocol) and compare your results.

Model Question Paper ELECTRONICS AND COMMUNICATION-EC3

Course Code: 221EEC016

Course Name: INFORMATION HIDING AND DATA ENCRYPTION

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

PART A

Answer all Questions. Each question carries 5 marks

Sl. No.	Question	CO
1.	Find the remainder when 16^{53} is divided by 7	1
2.	Describe the parameters used for measuring the capability of hiding techniques	1
3.	Identify the techniques used for tamper detection in image and audio and explain how the detection is carried out.	1
4.	Suggest a mathematical model for protecting the bio-medical signals and justify.	2
5.	Explain detection theoretic approach for steganalysis.	2

PART B

Answer any one full question from each module. Each question carries 7 marks

6.	Derive a general formula to calculate the number of each kind of transformation (SubBytes, ShiftRows, MixColumns, and AddRoundKey) and the number of total transformations for AES192 and AES256. The formula should be parametrized on the number of rounds.	1
7.	Write down algorithm for embedding and retrieval of text data using spread spectrum technique.	2
8.	Derive a mathematical model for hiding an image and explain.	2
9.	Differentiate between adaptive and non-adaptive techniques for information hiding. Which are the adaptive techniques used for hiding audio?	2
10.	Write down the encoding and decoding process for image hiding in the DCT domain and explain.	2
11.	Discuss temporal and transform domain techniques used in video using relevant examples.	2
12.	Illustrate SVM method for steg-analysis	2

Syllabus

ELECTRONICS AND COMMUNICATION-EC3

Module1:

Review of Number Theory: Elementary Number theory, Algebraic Structures- Groups, Rings and Finite Fields, Polynomials over Finite Fields (F_q), Introduction to Complexity theory.

Data Encryption Methods: Introduction to Cryptography, Classical Cryptography, Stream Ciphers, Public Key Cryptography based on Knapsack problem, AES. Digital Signature, Zero Knowledge Proofs.

Module2:

Introduction to Information Hiding: Steganography. Objectives, difference, requirements, Types – Fragile, Robust. Parameters and metrics - BER, PSNR, WPSNR, Correlation coefficient, MSE, and Bit per pixel.

Information Hiding Approaches: LSB, additive and spread spectrum methods.

Module3:

Digital Watermarking: Algorithms, Types of Digital Watermarks, Applications, Audio Watermarking

Applications of Information Hiding: Authentication, annotation, tamper detection and Digital rights management. Hiding text and image data, mathematical formulations.

Module4:

Information Hiding in 1D signals: Time and transform techniques, hiding in Audio, biomedical signals, HAS Adaptive techniques.

Information Hiding in 2D signals: Spatial and transform techniques-hiding in images, ROI images.

Module5:

Information Hiding in video: Temporal and transform domain techniques, Bandwidth requirements, HVS Adaptive techniques.

Steg analysis: Statistical Methods, HVS based methods, SVM method, Detection theoretic approach.

Course Plan

No	Topic	No. of Lectures
1	**Review of Number Theory and Data Encryption Methods:**	
1.1	Elementary Number theory	1
1.2	Algebraic Structures- Groups, Rings and Finite Fields, Polynomials over Finite Fields (F_q)	2
1.3	Introduction to Complexity theory.	1
1.4	Introduction to Cryptography, Classical Cryptography, Stream Ciphers	2
1.5	Public Key Cryptography based on Knapsack problem	2
1.6	AES. Digital Signature, Zero Knowledge Proofs.	2
2	**Information Hiding**:	
2.1	Steganography. Objectives, difference, requirements	2
2.2	Types – Fragile, Robust. Parameters and metrics - BER, PSNR, WPSNR, Correlation coefficient, MSE, and Bit per pixel.	3
2.3	Information Hiding Approaches: LSB, additive and spread spectrum methods.	3
3	**Digital Watermarking and applications of Image Hiding:**	
3.1	Digital Watermarking Algorithms	2
3.2	Types of Digital Watermarks and Applications	1
3.3	Audio Watermarking	1
3.4	Applications of Information Hiding: Authentication, annotation, tamper detection and Digital rights management	2
3.5	Hiding text and image data, mathematical formulations.	2
4	**Information Hiding in 1D and 2D signals:**	
4.1	Information Hiding in 1D signals: Time and transform techniques, hiding in Audio, biomedical signals, HAS Adaptive techniques.	3
4.2	Information Hiding in 2D signals: Spatial and transform techniques-hiding in images, ROI images, HVS Adaptive techniques.	4
5	**Information Hiding in video and Steg analysis:**	
5.1	Information Hiding in video: Temporal and transform domain techniques, Bandwidth requirements.	3
5.2	Steg analysis: Statistical Methods, HVS based methods, SVM method, Detection theoretic approach.	4

Reference Books

1. Neal Koblitz, A Course in Number Theory and Cryptography, 2nd Edition, Springer
2. Stefan Katzenbeisser, Fabien A. P. Petitcolas, Information Hiding Techniques for Steganography and Digital Watermarking, Artech House Publishers, 2000.
3. Neil F Johnson et al Kluwer, Information hiding: Steganography and Watermarking - Attacks and Countermeasures,Springer, 2001.

4. Ingemar J Cox, Digital Watermarking, The Morgan Kaufman Series in Multimedia Information and Systems, 2001
5. Ira S Moskowits, Information Hiding, Proceedings, 4th International Workshop, IH 2001, Pittsburg, USA, April 2001, Eds:2. AVISPA package homepage, http:/www.avispaproject.org/
6. Handbook of Applied Cryptography, AJ Menezes, CRC Press, 2001.

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
221EEC017	PROGRAMMING TOOLS FOR MODELING AND SIMULATION	PROGRAM ELECTIVE 1	3	0	0	3

Preamble: This course is about learning the programming languages used in the development of embedded systems. Learners can use the concepts learned in this course for the development of processor based systems.

Course Prerequisites: Basic knowledge in programming, and embedded systems. Knowledge on ARM processors or any other processors and their architecture is a requirement.

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

CO 1	To understand the Linux system and command level programming
CO 2	To understand the c programming basics
CO 3	To apply the c programming language in ARM programming
CO 4	To understand the basics of python language and its constructs
CO 5	To apply the python language in embedded applications

Mapping of course outcomes with program outcomes

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

Assessment Pattern

Bloom's Category	End Semester Examination (Marks)
Apply	20
Analyse	20
Evaluate	
Create	20

Mark distribution

Total Marks	CIE	ESE	ESE Duration
100	40	60	2.5 hours

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

Continuous Internal Evaluation Pattern:

Continuous Internal Evaluation: 40 marks

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

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

Test paper, 1 no. : 10 marks

Test paper shall include minimum 80% of the syllabus.

All course based assignments/tasks shall be of programming examples/ programming implementations of embedded systems. Review article can be prepared on embedded application implementations, embedded processors,

End Semester Examination Pattern:

The end semester examination will be conducted by the respective College. Therewill be two parts; Part A and Part B.

Part A will contain 5 numerical/short answerquestions with 1 question from each module; having 5 marks for each question (suchquestions shall be useful in the testing of knowledge, skills, comprehension,application, analysis, synthesis, evaluation and understanding of the students).Students should answer all questions.

Part B will contain 7 questions (such questionsshall be useful in the testing of overall achievement and maturity of the students in acourse, through long answer questions relating to theoretical/practical knowledge,derivations, problem solving and quantitative evaluation), with minimum one questionfrom each module of which student should answer any five. Each question can carry7 marks.

Note: The marks obtained for the ESE for an elective course shall not exceed20% over the average ESE mark % for the core courses. ESE marks awarded to astudent for each elective course shall be normalized accordingly. For example if theaverage end semester mark % for a core course is 40, then the maximum eligiblemark % for an elective course is 40+20 = 60 %.

Model Question Paper

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

FIRST SEMESTER M. TECH DEGREE EXAMINATION, (Model Question Paper)

Program: M.Tech. in EC3 (Signal Processing, Signal Processing & Embedded Systems, Communication Engineering & Signal Processing)

Course Code: 22EEC017

Course Name: PROGRAMMING TOOLS FOR MODELING AND SIMULATION

Max. Marks: 60 **Duration: 150 Minutes**

PART A

Answer ALL Questions. Each Carries 5 mark.

1. Write a C program to read an English Alphabet through keyboard and display whether the given Alphabet is in upper case or lower case.
2. With a suitable example, explain how pointers can help in changing the content of a single dimensionally array passed as an argument to a function in C.
3. Write a python program to print odd numbers from 1 to N.
4. How will you plot magnitude spectrum in Matplotlin in Python?
5. Explain virtual desktop. How do you share a program across different virtual desktops under Linux?

PART – B

Answer any 5 questions; each question carries 7 marks.

6. Write a Linux X window program to create a window with a little black square in it and exits on a key press.
7. Explain the features of the Linux system? Why Linux is regarded as a more secure operating system than other operating systems?
8. Write a C program to find the transpose of a matrix.
9. Write an embedded C ARM I/O program to display a message on the LCD using 8-bit mode and delay.
10. Write Python code to multiply two matrices using nested loops and also perform transpose of the resultant matrix.
11. Write a note on the image processing function in Python.
12. Write a NumPy program to create an element-wise comparison (equal, equal within a tolerance) of two given arrays

Syllabus

Module I (8 Hrs.)

Linux: Introduction, The shell, Shell script and programming, Shell configuration, Linux files, directories and archives. The X window system, Xorg, and Display managers, Gnome, KDE, Linux software management.

Module II (8 Hrs.)

Embedded Programming: C programming, Constants, variables and data types, operators and Expressions, I/O operations, Control flow statements (if else, switch, loops), Arrays and strings, Functions, structures and unions, Pointers, file management, Dynamic memory allocation and Linked lists.

Module III (8 Hrs.)

Embedded C Programming using embedded IDE. ARM I/O programming, LED, LCD, Keypad interfacing, UART,SPI,I2C programming, Timer programming, Interrupt and Exception programming, ADC, DAC, Sensor interfacing.

Module IV (8 Hrs.)

Python Programming basics: variables, Input, Output, Basic operations, String manipulation, Loops, functions, Lists, Dictionary.

Module V (8 Hrs.)

Python programming- Advanced python, Formatting, class, files, exceptions.

Course Plan

No	Topic	No. of Lectures
1	Linux: Introduction, The shell, Shell script and programming, Shell configuration, Linux files, directories and archives. The X window system, Xorg, and Display managers, Gnome, KDE, Linux software management.	
1.1	Linux : Introduction, distributions, accessing linux system, deskop and command line interface	3
1.2	The shell, Shell script and programming, Shell configuration, Linux files, directories and archives.	3
1.3	The X window system, Xorg, and Display managers, Gnome, KDE, Linux software management.	2
2	Embedded Programming: C programming, Constants, variables and data types, operators and Expressions, I/O operations, Control flow statements (if else, switch,	

	loops), Arrays and strings, Functions, structures and unions, Pointers, file management, Dynamic memory allocation and Linked lists.	
2.1	Embedded Programming: C programming, Constants, variables and data types, operators and Expressions, I/O operations,	3
2.2	Control flow statements (if else, switch, loops), Arrays and strings, Functions, structures and unions,	3
2.3	Pointers, file management, Dynamic memory allocation and Linked lists.	2
3	Embedded C Programming using embedded IDE. ARM I/O programming, LED, LCD, Keypad interfacing, UART,SPI,I2C programming, Timer programming, Interrupt and Exception programming, ADC, DAC, Sensor interfacing	
3.1	Embedded C Programming using embedded IDE. ARM I/O programming, LED, LCD, Keypad interfacing	3
3.2	UART,SPI,I2C programming, Timer programming,	3
3.3	Interrupt and Exception programming, ADC, DAC, Sensor interfacing	2
4	Python Programming basics : variables, Input, Output, Basic operations, String manipulation, Loops, functions, Lists, Dictionary	
4.1	Python Programming basics : variables, Input, Output, Basic operations,	3
4.2	String manipulation, Conditional instructions, Loops, functions,	3
4.3		2
5	Python programming- Advanced python, Formatting, class, files, exceptions, linux commands, web server, Signal plotting and processing (numpy and matplotlib), Graphics, Computer vision. Programming examples of systems.	
5.1	Python programming- Advanced python, Formatting, class, files, exceptions	3
5.2	linux commands, web server, Signal plotting and processing (numpy and matplotlib),	3
5.3	Graphics, Computer vision. Programming examples of systems.	2

Text Books

1. E. Balagurusamy, Programming in ANSI C, Tata McGraw-Hill, 6th Edition 2012
2. Muhammad Ali Mazidi, Shujen Chen, Sarmad Naimi, SepehrNaimi, “Freescale ARM Cortex-M Embedded Programming using C language”, Mazidi and Naimi,2014
3. Simon Monk, “Raspberry Cook Book Software and Hardware Problems and Solutions”, 2nd Edition, O’ Reilly Media Inc., 2016.
4. Richard Petersen, "Linux: The Complete Reference", 2017, Sixth Edition, McGraw Hill Education

Reference Books

1. David Russell, “Introduction to Embedded systems Using ANSI C and the Arduino development Environment”, 2010, 1rd edition, Morgan & Claypool Publishers.
2. E.I. Horvath, E.A. Horvath, “Learning IoT with Python and Raspberry Pi”, Learning IoT LLC, 2019.
3. Sarmad Naimi, Muhammad Ali Mazidi, SepehrNaimi, “The STM32F103 Arm Microcontroller and Embedded Systems: Using Assembly and C”, MicroDigitalEd, 2020

SEMESTER I

PROGRAM ELECTIVE II

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
221EEC018	DSP PROCESSORS AND ARCHITECTURE	PROGRAM ELECTIVE 2	3	0	0	3

Preamble: The aim of the course is to give an overview of the commonly used DSPalgorithms, their applications and various techniques for the algorithmic and architecturelevel optimisations through various algorithm to architecture mapping which can lead to efficient hardware implementations. The course also introduces the basic features in DigitalSignal Processors,Micro controllers with DSP extensions, DSP Architecture with case studies, the latest architectural trends in DSPsand their programming tools.

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

CO 1	Analyse the basic resource constraints in a practical DSP system and solve them using various techniques/transformations that map the DSP algorithms to efficient architectures.
CO 2	Apply the knowledge of various single core and multicore Digital Signal Processor architectures in identifying the optimal processor for solving real life signal processing problems.
CO 3	Evaluate the DSP algorithms implemented in dedicated DSP processors and the micro controllers with DSP extensions
CO 4	Create algorithms to solve signal processing problems using the latest hardware platforms and software tools.

Mapping of course outcomes with program outcomes

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

Assessment Pattern

Bloom's Category	End Semester Examination
Apply	20
Analyse	15
Evaluate	15
Create	10

Mark distribution

Total Marks	CIE	ESE	ESE Duration
100	40	60	2.5 hours

Continuous Internal Evaluation Pattern:

Continuous Internal Evaluation: 40 marks

Preparing a review article based on peer reviewed Original publications (minimum 10) Publications shall be referred): 15 marks

Course based task/Seminar/Data Collection and interpretation: 15 marks

Test paper, 1 no.: 10 marks

Test paper shall include minimum 80% of the syllabus.

End Semester Examination Pattern:

The end semester examination question paper consists of 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 (such questions shall be useful in the testing of knowledge, skills, comprehension, application, analysis, synthesis, evaluation and understanding of the students). 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.

Syllabus

Module 1: Basics of DSP Algorithm Representation to Architecture Mapping

DSP Algorithm representations –Block Diagram, Signal Flow Graph, Data Flow Graph, Dependence Graph;

Introduction to Filter structures- Recursive, Non-recursive and Lattice structures;

Fundamentals of DSP algorithm to architecture mapping - Loop bound, Iteration Bound, Critical Path;

Algorithms for computing Iteration Bound – Longest Path Matrix Algorithm, Minimum Cycle Mean Algorithm.

Module 2: Transformations for Improved DSP Architectures

VLSI performance measures - area, power, and speed;
Pipelining - Pipelining of FIR filters, Concept of Fine Grain Pipelining;
Parallel Processing – Designing Parallel FIR systems;
Pipelining and Parallel Processing for low power;
Folding and Unfolding Transformations and its applications.

Module 3: Single Core DSP Architectures

Introduction to General Purpose Processors (GPP), Microcontroller Units (MCU), Digital Signal Processors (DSP) - comparison and Applications;
The key features of a Digital Signal Processors – Dedicated hardware units, Circular Buffers, Modified bus structures and Memory access schemes;
Introduction to Harvard, Super Harvard DSP architectures, Concept of Instruction Level Parallelism, VLIW Architecture and Single Instruction Multiple Data (SIMD) processor architecture;
Case Study 1: Introduction to a popular DSP from Texas Instruments, The TMS320C67xx Series Processor- CPU Architecture - CPU Data Paths and Control - Timers – Multichannel Buffered Serial Ports (McBSPs)- Internal Data/ Program Memory - External Memory Interface.

Case Study 2: Introduction to ARM Cortex-M Based Microcontrollers with DSP extensions - ARMv7E-M architecture

Module 4: Homogeneous Multicore DSPs

Introduction to multicore processors and their applications, A brief comparison between DSP SoCs, Field-Programmable Gate Arrays (FPGAs), Graphic Processors and CPUs;
Introduction to Multicore DSP Architectures: The TMS320C66x
architecture: The CPU, Overview of the peripherals, Overview of the memory organization.

Module 5: Programming the DSPs

Introduction to Code Composer Studio (CCS) software development tool and the TMS320C6XX EVM kit. Introduction to Keil Development tool, CMSIS DSP software library and ARM Cortex-M4 development board;
Introduction to Open MP Application Programming Interface (API) and Open Computing Language (OpenCL);
Implementation of simple DSP algorithms;
Latest architectural trends in digital signal processing: Introduction to Heterogeneous Multicore DSP Architecture and FPGA SoCs.

Course Plan

No	Topic	No. of Lectures
1	**Basics of DSP Algorithm Representation to Architecture Mapping**	
1.1	DSP Algorithm representations –Block Diagram, Signal Flow Graph,Data Flow Graph, Dependence Graph.	2
1.2	Introduction to Filter structures- Recursive, Non-recursive and Lattice structures.	1
1.3	Fundamentals of DSP algorithm to architecture mapping - Loop bound,Iteration Bound, Critical Path.	2
1.4	Algorithms for computing Iteration Bound – Longest Path Matrix Algorithm, Minimum Cycle Mean Algorithm.	2
2	**Transformations for Improved DSP Architectures**	
2.1	VLSI performance measures - area, power, and speed	1
2.2	Pipelining - Pipelining of FIR filters, Concept of Fine Grain Pipelining.	2
2.3	Parallel Processing – Designing Parallel FIR systems.	2
2.4	Pipelining and Parallel Processing for low power.	1
2.5	Folding and Unfolding Transformations and its applications.	2
3	**Single Core DSP Architectures**	
3.1	Introduction to General Purpose Processors (GPP), Microcontroller Units (MCU), Digital Signal Processors (DSP) - comparison and Applications.	1
3.2	The key features of a Digital Signal Processors – Dedicated hardware units, Circular Buffers, Modified bus structures and Memory access schemes.	1
3.3	Introduction to Harvard, Super Harvard DSP architectures, Concept of Instruction Level Parallelism, VLIW Architecture and Single Instruction Multiple Data (SIMD) processor architecture.	1
3.4	Case Study 1: Introduction to a popular DSP from Texas Instruments, The TMS320C67xx Series Processor- CPU Architecture - CPU Data Paths and Control - Timers – Multichannel Buffered Serial Ports (McBSPs)- Internal Data/ Program Memory - External Memory Interface.	3
3.5	Case Study 2: Introduction to ARM Cortex-M Based Microcontrollers with DSP extensions - ARMv7E-M architecture	3
4	**Homogeneous Multicore DSPs**	
4.1	Introduction to multicore processors and their applications, A brief comparison between DSP SoCs, Field-Programmable Gate Arrays (FPGAs), Graphic Processors and CPUs.	1

4.2	Introduction to Multicore DSP Architectures: The TMS320C66x architecture: The CPU, Overview of the peripherals, Overview of the memory organization.	4
5	**Programming the DSPs**	
5.1	Introduction to Code Composer Studio (CCS) software development tool and the TMS320C6XX EVM kit Introduction to Keil Development tool, CMSIS DSP software library and ARM Cortex-M4 development board	3
5.2	Introduction to Open MP Application Programming Interface (API) and Open Computing Language (OpenCL).	2
5.3	Implementation of simple DSP algorithms	2
5.4	Latest architectural trends in digital signal processing: Introduction to Heterogeneous Multicore DSP Architecture and FPGA SoCs.	1

Text Books

1. Keshab K. Parhi, "VLSI Signal Processing Systems, Design and Implementation", John Wiley &Sons,1999
2. NaimDahnoun, “Multicore DSP: from algorithms to real-time implementation on the TMS320C66x SoC”. John Wiley & Sons, 2018.
3. Steven W. Smith, “The Scientist and Engineer’s Guide to Digital Signal Processing” Second Edition, California Technical Publishing , 1999.
4. Reference Link for Overview of Latest Processor Architectures– Digital signal processors (DSPs) | Overview | Processors | TI.com, https://training.ti.com/system/files/docs/c66x-corepac-instruction-set-referenceguide.pdf
5. Joseph Yiu “The Definitive Guide to ARM® Cortex®-M3 and Cortex®-M4 Processors”, Elsevier, 2014

Reference Books

1.RulphChassaing, “Digital Signal Processing and Applications with the C6713 and C6416 DSK”, John Wiley & Sons, 2005.

2.Sen M. Kuo, Woon-Seng S. Gan, Digal Signal Processors: Architectures, Implementations, and Applications, Prentice Hall, 2004.

3.Lars Wanhammar, DSP Integrated Circuits, Academic Press, 1999.

4.B Venkataramani, M Bhaskar, “Digital Signal Processors: Architecture, Programming and Applications”, 2nd Ed., Tata McGraw-Hill Education, 2002.

5. A. Kharin, S. Vityazev and V. Vityazev, "Teaching multi-core DSP implementation on EVM C6678 board," 2017 25th European Signal Processing Conference (EUSIPCO), 2017, pp. 2359-2363, doi: 10.23919/EUSIPCO.2017.8081632

6.Donald S. Reay.. “Digital Signal Processing Using the ARM Cortex M4”, (1st. ed.). Wiley Publishing, 2015

7.CemÜnsalan, M. ErkinYücel, H. DenizGürhan, “Digital Signal Processing Using Arm Cortex-M Based Microcontrollers: Theory and Practice”, ARM Education Media, 2018.

Model Question Paper ELECTRONICS AND COMMUNICATION-EC3

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

FIRST SEMESTER M. TECH DEGREE EXAMINATION, (**Model Question Paper)**

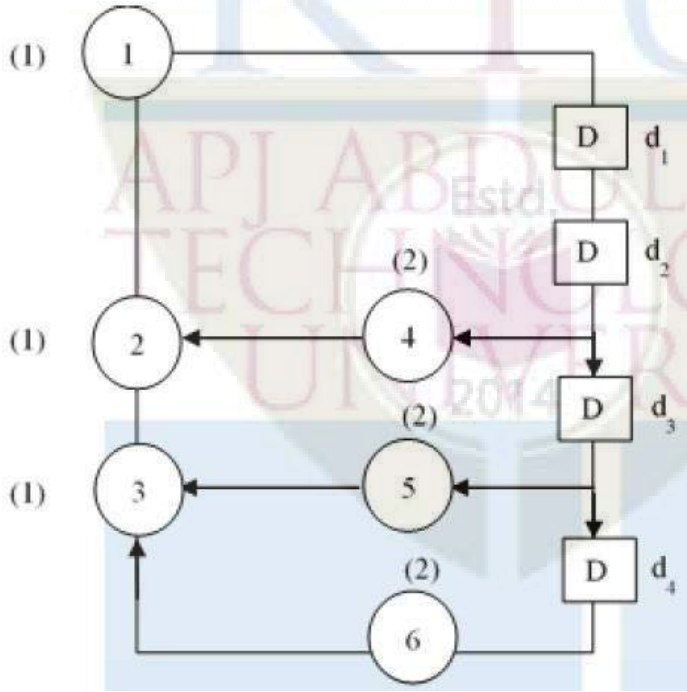
Course Code: 221EEC018

Course Name: DSP PROCESSORS AND ARCHITECTURE

Max. Marks: 60 Duration: 2.5 Hours

PART A

Answer all Questions. Each Carries 5 mark.

1	Differentiate between Signal Flow Graph (SFG) and Data Flow Graph (DFG) with example.
2	What is pipelining? Explain with an example, how it helps in reducing the critical path delay in implementing the DSP systems.
3	In what way the Super Harvard architecture-based DSPs differs from the normal microprocessors?
4	What is the concept of Heterogeneous Multicore DSP Architecture? Quote an example processor?
5	Quoting a suitable example, explain the architectural advantages of an FPGA SoC.
	PART – B (Answer any five questions, each carries 7 mark.)
6	Explain the Longest Path Matrix (LPM) Algorithm for computing the iteration bound of a DFG. For the DFG shown in figure below, the computation times of the nodes are shown in parentheses. Compute the iteration bound of this DFG using the LPM algorithm. 
7	For the following transfer function given, Derive the basic lattice filter and draw its structure

	$H(z) = \frac{3.9 + 2.3z^{-1} + z^{-2}}{1 + 0.3z^{-1} + 0.5z^{-2}}$ ELECTRONICS AND COMMUNICATION-EC3 $H(z) = \frac{-3 + 5.192z^{-1} - 3.56z^{-2} + 2z^{-1}}{1 + 0.28z^{-1} + 0.056z^{-2} + 0.4z^{-3}}$
8	Consider a direct-form implementation of the FIR filter y(n) = ax(n) + bx(n-2) +cx(n-3) Assume that the time required for 1 multiply-add operation is T i. Pipeline this filter such that the clock period is approximately T ii. Draw block filter architecture for a block size of three. Pipeline this block filter such that clock period is about T. What is the system sample
9	The TMS320C6713 processor is used for an application where, it has to read the audio data inputted through the codec and has to send the data which is band limited to 1 KHz, to another external device for further processing. If the processor is connected to the audio codec through the McBSPs of the TMS320C6713 processor. a)Draw the interconnection diagram showing all the necessary signals, for inputting an analog signal to the processor for the processing and to send the result there after, with the entire data transfer initiated through the McBSPs. b)What are the various registers need to be programmed in order to affect the data transfer? Explain the role and functionality of each.
10	Draw a neat block schematic of the architecture of TMS320C66x series of processor. Briefly explain the role of each block.
11	Give an overview of the memory organisation in TMS320C66xx series of processors. Explain the role of various memory controllers and interfaces in relieving the CPU load.
12	Give an overview of the latest architectural trends for implementing DSP algorithms. How will you compare FPGA SoCs and DSP SoCs?.

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
221EEC019	CODING THEORY	PROGRAM ELECTIVE 1	3	0	0	3

Preamble: This course aims at a rigorous analysis of various error correction codes starting from the earliest Hamming code to the latest polar codes used in 5G

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

CO 1	Analyse block codes and various bounds governing their construction
CO 2	Analyse LDPC coding and hard decision/soft decision decoding
CO 3	Illustrate coding and decoding of BCH/RS codes
CO 4	Review convolutional encoding and decoding them using BCJR algorithm
CO 5	Illustrate coding and decoding of Turbo codes
CO 6	Discuss polar codes and their applications in 5G

Mapping of course outcomes with program outcomes

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

Assessment Pattern

Bloom's Category	End Semester Examination
Apply	10
Analyse	25
Evaluate	20
Create	5

Mark distribution

Total Marks	CIE	ESE	ESE Duration
100	40	60	2.5 hours

Continuous Internal Evaluation Pattern:

Continuous Internal Evaluation: 40 marks

- Preparing a review article based on peer reviewed Original publications (minimum 10 publications shall be referred) : 15 marks
- Course based task/Seminar/Data collection and interpretation:15 marks
- Test paper, 1 no. :10 marks

Test paper shall include minimum 80% of the syllabus

End Semester Examination Pattern:

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 with minimum one question from each module of which student should answer any five. Each question can carry 7 marks.

Model Question Paper

A P J ABDUL KALAM TECHNOLOGICAL UNIVERSITY
M.TECH DEGREE EXAMINATION
FIRST SEMESTER
CODING THEORY

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

PART A

Answer All Questions 5 x 5 marks = 25 marks

1. Explain Hamming bound and Gilbert-Varshamov bound
2. Analyse the effect of short-cycles in the decoding of LDPC codes
3. Show that the dual of an RS code is also an RS code (and hence MDS)
4. Construct the Generator matrix of a RM(1,3) code
5. Discuss the encoding of Turbo codes

PART B

Answer any 5 questions 5 x 7 marks = 35marks

6.The parity check bits of a (8,4) block code are generated by, $p_0 = m_0 + m_1 + m_3$, $p_1 = m_0 + m_1 + m_2$, $p_2 = m_0 + m_2 + m_3$, $p_3 = m_1 + m_2 + m_3$ where m_0 , m_1, m_2 and m_3 are the message digits.

a) Find the generator matrix and the parity check matrix for this code in the form $G=[P:I_k]$

b) Find the minimum weight of this code.

c) Find the error-detecting capabilities of this code.

d) Check whether 11101000 and 11100000 are valid codewords using H matrix.

7. a)Explain hard decision decoding of LDPC codes using Bit-flipping algorithm in BSC.
b) .Explain BCJR decoding of convolutional codes

8. For a binary, narrow sense, triple error correcting BCH code of length 15, constructed using the polynomial x^4+x+1

(a) Compute a generator polynomial for this code

(b) Determine the rate of the code

(c) Construct the parity check matrix and generator matrix for this code

9. Form the generator matrix of the first order RM code RM (1, 3) of length 8. What is the minimum distance of the code? Determine its parity check sums and devise a majority logic decoder for the code. Decode the received vector r = (01000101)
10. Describe the basic ideas of polarization. Analyse mathematically channel polarisation for N=2 channel

11.Analyze the iterative soft decoding of Turbo codes

12. Differentiate between the BCH Viewpoint and Vandermonde viewpoints of Reed Solomon Codes

Syllabus

Module 1 Linear Block Codes and Bounds: Course Overview-Relevance of Error correction schemes in communication systems, Repetition coding, concepts of Code rate, Hamming Distance, Minimum Distance, Error detecting and correcting capability, Review of Group, ring, fields and vectorspaces, Hamming bound, Singleton bound, Plotkin bound, Gilbert-Varshamov bound

Module 2 LDPC Codes Regular and Irregular Low Density Parity Check Codes-Tanner graph, Message Passing decoding-Hard decision and Soft decision, Bit flipping algorithm for decoding, Bit flipping algorithm for decoding, Belief Propagation decoding: Sum Product algorithm

Module 3 BCH and RS codes Galois Fields -- Irreducible and Primitive Polynomials- BCH Codes - Design, BCH Bound, Decoding BCH codes – Decoding BCH – the general outline, computation of the syndrome, error locator polynomial, Chien Search algorithm, Finding the error locator polynomial. Berlekamp Massey Algorithm. Burst-error correction capability of BCH codes. Reed Solomon Codes – BCH code viewpoint. Vandermonde matrix view point

Module 4 Convolutional Codes and Turbo codes Review of convolutional codes : Encoding, state diagram, trellis diagram , Viterbi Decoding, BCJR algorithm, Turbo Codes: Turbo encoder, Parallel concatenation decoding

Module 5 Reed-Muller Codes and Polar Codes Reed Muller Codes, Encoding and decoding of RM (1, m) codes. Majority-logic decoding of Reed-Muller codes. Polar Codes – Introduction, polarization of BEC channels, Polar transform and frozen bits.

Course Plan

No	Topic	No. of Lectures
1	**Linear Block Codes and Bounds**	
1.1	Course Overview-Relevance of Error correction schemes in communication systems	1
1.2	Repetition coding, concepts of Code rate, Hamming Distance, Minimum Distance, Error detecting and correcting capability.	1

1.3	Review of Group,ring, fields and vector spaces	1
1.4	Linear Block codes-Generator and parity check matrices,encoding, standard array and syndrome decoding, Hamming codes	2
1.5	Maximum Distance Separable (MDS) codes	1
1.6	Bounds on size of codes: Hamming bound, Singleton bound, Plotkin bound, Gilbert-Varshamov bound	2
2	**LDPC Codes**	
2.1	Regular and Irregular Low Density Parity Check Codes-Tanner graph	1
2.2	Message Passing decoding-Hard decision and Soft decision	1
2.3	Message passing decoding in a BEC	1
2.4	Bit flipping algorithm for decoding	1
2.5	Belief Propagation decoding: Sum Product algorithm	2
3	**BCH and RS codes**	
3.1	Galois Fields -- Irreducible and Primitive Polynomials, Primitive elements, Field extension, Conjugate elements and Minimal Polynomials. Cyclotomiccosets.	2
3.2	BCH Codes - Design, BCH Bound, Decoding BCH codes – Decoding BCH – the general outline, computation of the syndrome, error locator polynomial, Chien Search algorithm, Finding the error locator polynomial. Berlekamp Massey Algorithm. Burst-error correction capability of BCH codes.	4
3.3	Reed Solomon Codes – BCH code viewpoint. Vandermonde matrix view point. MDS property. Generalized Reed-Solomon codes. Application of BCH decoding algorithms to Reed-Solomon decoding. Sudan's algorithm for decoding. Use of RS codes in disks and cloud storage.	4
4	**Convolutional Codes and Turbo codes**	
4.1	Review of convolutional codes: Encoding, state diagram, trellis diagram	1
4.2	Review of convolutional codes: Viterbi Decoding	1
4.3	Decoding of convolutional codes: BCJR algorithm	2
4.4	Turbo Codes: Turbo encoder, Parallel concatenation decoding	3
5	**Reed-Muller Codes and Polar Codes**	
5.1	Reed Muller Codes, Encoding and decoding of RM (1, m) codes. Majority-logic decoding of Reed-Muller codes.	4
5.2	Polar Codes – Introduction, polarization of BEC channels, Polar transform and frozen bits.	4

Text Books

1. Shu Lin, D. J Costello Jr. Error Control Coding: Fundaments and Applications, Prentice Hall

Reference Books:

1. Ron M Roth, Introduction to Coding Theory, Cambridge University Press

2. T. Richardson, R. Urbanke, Modern Coding Theory, Cambridge University Press

3. A. Thangaraj, LDPC and Polar Codes in 5G Standard, NPTEL

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
221EEC020	MULTIRATE SIGNAL PROCESSING AND WAVELETS	PROGRAM ELECTIVE 2	3	0	0	3

Preamble: Multirate systems play a central role in many areas of signal processing, such as filter bank theory and multiresolution theory. This course imparts a comprehensive knowledge of topics in multirate signal processing and wavelets, essential in some of the standard signal processing techniques such as signal analysis, denoising and other applications.

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

CO 1	Apply sampling rate conversions, decimation and interpolation as part of Signal Processing techniques
CO 2	Design a perfect reconstruction filter bank system
CO 3	Analyze the signal decomposition and reconstruction using tree structured filter banks
CO 4	Design an orthogonal/biorthogonal wavelet system according to the application.
CO 5	Implement the wavelet based decomposition using appropriate filter bank structure
CO 6	Apply wavelets for signal analysis and other applications

Mapping of course outcomes with program outcomes

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

Assessment Pattern

Bloom's Category	End Semester Examination
Apply	30
Analyse	20
Evaluate	10
Create	

Total Marks	CIE	ESE	ESE Duration
100	40	60	2.5 hours

Continuous Internal Evaluation Pattern:

Preparing a review article based on peer reviewed original publications (minimum 10 Publications shall be referred):	15 marks
Course based task/Seminar/Data Collection and interpretation:	15 marks
Test paper, 1 no.: (Test paper shall include minimum 80% of the syllabus.)	10 marks

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 (such questions shall be useful in the testing of knowledge, skills, comprehension, application, analysis, synthesis, evaluation and understanding of the students). 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.

Model Question Paper

ELECTRONICS AND COMMUNICATION-EC3

Name:

Reg. No:

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY **E**

FIRST SEMESTER M.TECH DEGREE EXAMINATION

MULTIRATE SIGNAL PROCESSING AND WAVELETS

Subject: 221EEC020

Time: 2.5 Hours Maximum: 60 Marks

Part A

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

1. Obtain the type-I polyphase decomposition of decimation filter with transfer function $H(z) = 1 + 5z^{-1} + 10z^{-2} + 10z^{-3} + 5z^{-4} + z^{-5}$.

2. The prototype filter of a 2 channel QMF is given as $H_0(z) = a + bz^{-1} + cz^{-2} + dz^{-3} - ez^{-5}$. Design the remaining filtersof the filter bank.

3. Obtain the time frequency variation of the function$(t) = e^{-a|t|}$.

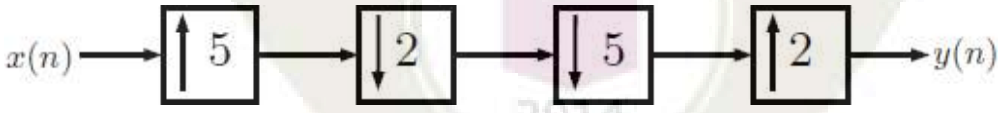
4. Differentiate the concepts of orthogonality and biorthogonality.

5.Explain how wavelets can be used for facial recognition.

Part B

Answer any FIVE full questions; each question carries 7 marks. (5x7=35)

6 a) Consider the following multirate system. Obtain the expression for its output. (3 Marks)



b) Derive the frequency domain input-output relation of a decimator. (4 Marks)

7. a) Design a sampling rate converter to convert a digital audio signal of 48kHz sampling rate to 32kHz sampling rate. (4 Marks)

b) Develop a computationally efficient realization of a factor of 3 interpolator employing a length 15 linear phase FIR filter. (3 Marks)

8. a) Design a 3 channel perfect reconstruction filter bank given its polyphase components as

$$E(z) = \begin{bmatrix} 1 & 2 & 3 \\ 0 & 1 & 4 \\ 5 & 6 & 0 \end{bmatrix}$$

(4 Marks)

b) For a two channel QMF, let the analysis filter
$H_0(z) = 2 + 5z^{-1} + 3z^{-2} - 8z^{-3} + 8z^{-4}$.
Design remaining analysis filters and synthesis filters which result in perfect reconstruction. Calculate the alias component matrix for the filter bank. (3 Marks)

9 a) Derive the constraint equations for the design of a Daubechies 6-tap orthogonal wavelet system. (7 Marks)

10 a) Explain B-spline scaling functions. Derive the B-spline scaling function of order 2 from Haar scaling function. (3 Marks)

b) Derive the filter bank structure to obtain the fine scale coefficients $s_{j+1}(k)$ of any signal f(t) from its smooth (s_j (k)) and detail coefficients (d_j (k)) at coarse resolution, and hence explain it with the required block diagram. (4 Marks)

11 a) Derive the analysis and synthesis side equations for a biorthogonal wavelet system. (7 Marks)

12. Deduce the method of decomposing a given sequence into wavelet packets using Haar wavelets and draw the decomposition tree with an example. (7 marks)

Syllabus

Module 1:Multi-rate System Fundamentals

Review of basic multi-rate operations: up sampling and down sampling, time domain and frequency domain analysis, Need for antialiasing and anti-imaging filters.Interpolator and decimator design, Noble identities.Type 1 and Type 2 polyphase decomposition, 2-channel and N-channelpolyphase decomposition .Efficient structures for decimation and interpolation filters, efficient structures for fractional sampling rate conversion.

Module 2:Multi-rate Filter Banks

Overview of Maximally decimated filter banks and non-maximally decimated filter bank. Uniform DFT filter banks - design, polyphase implementation.Two-channel critically sampled filter banks.Amplitude-Complementary 2-Channel Filter Bank
Example - Two channel Haar Filter bank and its polyphase decomposition, Quadrature mirror filter (QMF) bank, Errors in the QMF bank, conditions for perfect reconstruction, polyphase implementation. Design of perfect reconstruction M- channel Filter Banks, Overview of Uniform and non-uniform tree structured filter banks, Dyadic filter bank.

Module 3:Continuous and Discrete Wavelet Transform

Short Time Fourier Transform (STFT), STFT as a bank of filters, Choice of window function and time frequency trade-off.The Uncertainty Principle and Time Frequency Tiling,Continuous wavelet transform (CWT) and inverse CWT,Properties of Wavelets used in CWT, Admissibility condition.Concept of orthogonal and orthonormal basis functions, function spaces. Discrete Wavelet Transform.Haar Scaling Function, Nested Spaces, Haar Wavelet Function, Orthogonality of scaling and translate functions, Normalization of Haar Bases at different Scales, Refinement Relation with respect to normalized bases.Support of a Wavelet System, Daubechies Wavelets.

Module 4:Design of Orthogonal & Biorthogonal wavelets systems

Designing Orthogonal Wavelet systems - a direct approach, Frequency domain approach for designing wavelets. Implementation using tree structured QMF bank and equivalent M-channel filter bank.Designing Biorthogonal Wavelet systems: Biorthogonality in Vector Space, Biorthogonal Wavelet Systems.Signal Representation Using Biorthogonal Wavelet System,Biorthogonal Analysis and Biorthogonal Synthesis.Construction of Biorthogonal Wavelet Systems-B-splines,Computation of the discrete wavelet transform using Mallat Algorithm and Lifting Scheme

Module 5:Wavelet Packet Analysis and applications of wavelets

Wavelet Packet Transform – Signal representation using wavelet packet analysis
Applications of Wavelets and Wavelet Packets in Signal and Image compression
Wavelet based signal denoising.

Course Plan

No	Topic	No. of Lectures
1	**Multi-rate System Fundamentals:**	
1.1	Review of basic multi-rate operations: up sampling and down sampling, time domain and frequency domain analysis, Need for antialiasing and anti-imaging filters. Interpolator and decimator design, Noble identities.	3
1.2	Type 1 and Type 2 polyphase decomposition, 2-channel and N-channelpolyphase decomposition	2
1.3	Efficient structures for decimation and interpolation filters, efficient structures for fractional sampling rate conversion.	3
2	**Multi-rate Filter Banks**	
2.1	Overview of Maximally decimated filter banks and non-maximally decimated filter bank. Uniform DFT filter banks - design, polyphase implementation. Two-channel critically sampled filter banks Amplitude-Complementary 2-Channel Filter Bank Example - Two channel Haar Filter bank and its polyphase decomposition.	3

2.2	Quadrature mirror filter (QMF) bank , Errors in the QMF bank, conditions for perfect reconstruction, polyphase implementation	2
2.3	Design of perfect reconstruction M- channel Filter Banks	2
2.4	Overview of Uniform and non-uniform tree structured filter banks. Dyadic filter bank.	1
3	**Continuous and Discrete Wavelet Transform**	
3.1	Short Time Fourier Transform (STFT), STFT as a bank of filters, Choice of window function and time frequency trade-off.	2
3.2	The Uncertainty Principle and Time Frequency Tiling	1
3.3	Continuous wavelet transform (CWT) and inverse CWT. Properties of Wavelets Used in CWT, Admissibility condition.	2
3.4	Concept of orthogonal and orthonormal basis functions, function spaces. Discrete Wavelet Transform. Haar Scaling Function, Nested Spaces. Haar Wavelet Function, Orthogonality of scaling and translate functions, Normalization of Haar Bases at different Scales, Refinement Relation with respect to normalized bases. Support of a Wavelet System, Daubechies Wavelets.	4
4	**Design of Orthogonal & Biorthogonal wavelets systems**	
4.1	Designing Orthogonal Wavelet systems - a direct approach, Frequency domain approach for designing wavelets. Implementation using tree structured QMF bank and equivalent M-channel filter bank.	3
4.2	Designing Biorthogonal Wavelet systems: Biorthogonality in Vector Space, Biorthogonal Wavelet Systems. Signal Representation Using Biorthogonal Wavelet System, Biorthogonal Analysis and Biorthogonal Synthesis. Construction of Biorthogonal Wavelet Systems-B-splines	3
4.3	Computation of the discrete wavelet transform using Mallat Algorithm and Lifting Scheme	3
5	**Wavelet Packet Analysis and applications of wavelets**	
5.1	Wavelet Packet Transform – Signal representation using wavelet packet analysis	2
5.2	Applications of Wavelets and Wavelet Packets in Signal and Image compression	3
5.3	Wavelet based signal denoising.	2

Reference Books

1.P. P. Vaidyanathan, Multirate Systems and Filter Banks, Pearson Education, 2006.

2.Fredric J Harris, Multirate Signal Processing for Communication Systems, 1st Edition, Pearson Education, 2007

3.Sanjit K. Mitra, Digital Signal Processing: A Computer based Approach, Special Indian Edition,McGraw Hill, 2013.

4. Spectral Audio Signal Processing, Julius O. Smith III, W3K Publishing, 2011.

5. N.J. Fliege, Multirate Digital Signal Processing, John Wiley, 1994.

6. K. P. Soman, K. I. Ramachandran, N. G. Resmi, PHI, Insight into wavelets :From theory topractice

7. G.Strang& T. Nguyen , Wavelets and Filter bank, Wellesly-Cambridge

8. M. Vetterli& J. Kovacevic, Wavelets and sub band coding, Prentice Hall

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
221EEC021	ADAPTIVE SIGNAL PROCESSING	PROGRAM ELECTIVE 2	3	0	0	3

Preamble: This course introduces the design and analysis of signal processing algorithms which can automatically change the system parameters to get a desired output, when a stationary random signal is applied to it.

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

CO 1	Analyse stationary random signals and adaptive systems.
CO 2	Analyse performance of the gradient search algorithms.
CO 3	Evaluate the effect of gradient noise in weight vector solution.
CO 4	Analyse LMS algorithms, adaptive recursive filters and Kalman filters.
CO 5	Apply the adaptive systems for applications in system modelling and inverse adaptive modelling.

Mapping of course outcomes with program outcomes

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

Assessment Pattern

Bloom's Category	End Semester Examination
Understand	20%
Apply	70%
Analyse	10%
Evaluate	
Create	

Mark distribution

Total Marks	CIE	ESE	ESE Duration
100	40	60	2.5 hours

Continuous Internal Evaluation Pattern:

Preparing a review article based on peer reviewed original publications (minimum 10 Publications shall be referred):	15 marks
Course based task/Seminar/Data Collection and interpretation:	15 marks
Test paper, 1 no.: (Test paper shall include minimum 80% of the syllabus.)	10 marks

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 (such questions shall be useful in the testing of knowledge, skills, comprehension, application, analysis, synthesis, evaluation and understanding of the students). 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.

ELECTRONICS AND COMMUNICATION-EC3

Subject: 221EEC021

Model Question Paper

Name:

Reg. No: **E**

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

FIRST SEMESTER M. TECH DEGREE EXAMINATION

ADAPTIVE SIGNAL PROCESSING

Time: 2.5 Hours Maximum: 60 Marks

PART A (Answer all questions)

1 Prove that the autocorrelation of a non-zero wide sense stationary random sequence is positive definite. Compute the 2x2 auto correlation matrix of $x(n) = a + N(0,\sigma)$, where a and σ are constants, $N(.)$ refers to normal distribution. 5 marks

2 Compare and contrast various configurations of adaptive systems. Give one example for each. 5 marks

3. Evaluate the expression for MSE performance surface of a system with $R = \begin{bmatrix} 2 & 1 \\ 1 & 2 \end{bmatrix}$, $P = \begin{bmatrix} 5 \\ 6 \end{bmatrix}$, $E(d_k{}^2) = 11$ at the weight vector $w = \begin{bmatrix} 1 \\ 2 \end{bmatrix}$. Calculate ξ_{min}. 5 marks

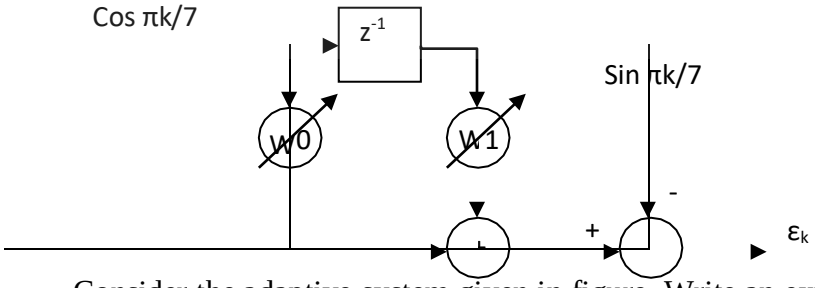
4. Obtain the expression for weight updation in the LMS algorithm. What is the condition for convergence in the LMS algorithm? 5 marks

5. Illustrate the method for adaptive modelling of earth's impulse response for geophysical exploration 5 marks

PART B (Answer any five question)

6 Compute the most significant two Eigen vectors of the correlation matrix $R = \begin{bmatrix} 4 & 3 & 0 \\ 3 & 6 & 2 \\ 0 & 2 & 4 \end{bmatrix}$ 7 marks

7. 7 marks



Consider the adaptive system given in figure. Write an expression for the

performance surface. Determine a range for the adaptive gain constant. Calculate W* and ξ_{min}.

Module 2

8.	Determine the autocorrelation matrix, performance penalty and perturbation of a two-weight system with performance surface $\xi = 16w_0^2 + 16w_1^2 + 6w_0 + 4w_1 + 16w_0 w_1 + 42$ and δ=1/4.	7 marks
9.	Derive the prediction and correction equations of the discrete Kalman Filter.	7 marks
10 a.	Derive the expressions for the weight updating in adaptive recursive filter.	5 marks
10 b.	Identify major challenges in adaptive recursive filter implementation.	2 marks
11.	Explain in detail about the adaptive modelling of multipath communication channels.	7marks
12	Derive the expression for the covariance of noise in the gradient estimation in the case of steepest descent method?	7marks

(For 3 credit courses, the content can be for 40 hrs)

Review of discrete time stochastic process and auto correlation matrix - Introduction to adaptive systems - performance functions - Gradient search methods -Gradient estimation and its effects on the adaptation - LMS algorithm - Adaptive recursive filters - discrete Kalman filter- application of adaptive filtering.

Course Plan

No	Topic	No. of Lectures
1	**Review of discrete time stochastic process and auto correlation matrix**	
1.1	Univariate and Multivariate random sequences, Gaussian noise	3
1.2	Autocorrelation matrix of stationary process and its properties	2
1.3	Eigen decomposition, properties of Eigen vectors, whitening	3
2	**Introduction to adaptive systems**	
2.1	Introduction to adaptive systems – definitions– characteristics– configurations – applications	2
2.2	Adaptive linear combiner – MSE performance function – Wiener-Hopf equation	2
2.3	Searching the MSE performance function – Newton's method for searching the performance function, stability and convergence	2
2.4	Steepest descent algorithm – Stability and convergence – Learning curve	2
3	**Gradient estimation and its effects on adaptation**	
3.1	Performance penalty and perturbation	2
3.2	Effects on weight vector solution, covariance of weight vector	3
3.3	Excess MSE, mis adjustment and time constants	2
4	Adaptive algorithms and structures	
4.1	LMS algorithm, Convergence of weight vector and learning curve	2
4.2	Adaptive recursive filters	2
4.3	Discrete Kalman Filter, filtering example	4
5	**Applications of adaptive filtering**	
5.1	Adaptive modelling of multipath communication channel	2
5.2	Adaptive modelling for FIR filter synthesis	2
5.3	Adaptive equalization of telephone channels	2
5.4	Adapting poles and zeros for IIR digital filter synthesis	2

Reference Books

1. Bernard Widrow and Samuel D. Stearns, Adaptive signal processing, Pearson education.
2. Simon Hykins, Adaptive filter theory, Fifth edition, Pearson education.
3. A. Papaulis and U. Pillai, Probability Random Variables and Stochastic Processes, 4th Edition, McGraw Hill Education.
4. S. Thomas Alexander, Adaptive Signal Processing – Theory and Applications, SpringerVerlag

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
221EEC022	INTERNET OF THINGS	PROGRAM ELECTIVE 2	3	0	0	3

Preamble: The core modules of this elective course include introduction to Internet of Things (IoT), IoT protocol and software, IoT point to point communication technologies, IoT security and IoT Platform. This course aims to teach the student to understand the concepts of IoT and its applications.

Prerequisites: NIL

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

CO 1	Identify the IoT networking components with respect to OSI layer.
CO 2	Understand the communication networks and protocols used in IoT
CO 3	Understand the cloud resources, data analysis and applications.
CO 4	Understand IoT security and threat models analysis.
CO 5	Understand various IoT applications and its variants.
CO 6	Design and develop prototype models for various IoT applications.

Mapping of course outcomes with program outcomes

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

Assessment Pattern

Bloom's Category	End Semester Examination
Apply	20
Analyse	20
Evaluate	
Create	20

Mark distribution

Total Marks	CIE	ESE	ESE Duration
100	40	60	2.5 hours

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

Continuous Internal Evaluation Pattern:

Continuous Internal Evaluation: 40 marks

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

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

Test paper, 1 no. : 10 marks

Test paper shall include minimum 80% of the syllabus.

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 (such questions shall be useful in the testing of knowledge, skills, comprehension, application, analysis, synthesis, evaluation and understanding of the students). 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.

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 %.

Model Question Paper

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

FIRST SEMESTER M. TECH DEGREE EXAMINATION, (Model Qtn Paper)

Program: M.Tech. in EC3 (Signal Processing, Signal Processing & Embedded Systems, Communication Engineering & Signal Processing)

Course Code: 221EEC022

Course Name: INTERNET OF THINGS

Max. Marks: 60 Duration: 150 Minutes

PART A

Answer All Questions. Each Carries 5 marks.

1. How is data link addressing different from network addressing?
2. Explain the CoAP message format.
3. Discuss the components in the open source cloud platform OpenStack..
4. List the standard encryption protocols used in IoT. Explain any one algorithm with example.
5. With the help of block diagram explain the IoT application in healthcare. Explain each modules of the network.

PART B

Answer any 5 questions: Each question carries 7 marks.

6. What is internet protocol suit? How is it differ from th ISO-OSI model?
7. Design an IoT based water quality monitoring system using MQTT protocol. Explain the publish subscribe model in detail.
8. Design a LoRa based smart street lighting system for smart cities (block diagram only). Discuss the security features of LoRaWAN.
9. Explain the requirements of privacy and security, vulnerabilities from threats, and need of threat-analysis in IoT
10. Discuss on the cryptographic functions and their security services.
11. How IoT is related to big data analytics? Explain with an example.
12. Design an M2M Smart meter which allow you to track energy consumption in real-time. Draw the block diagram of the network and explain each modules

SYLLABUS

Module 1: 8 hours

Introduction to IoT: Basics of Networking- network types,layered network models, addressing,TCP/IP Transport layer, Emergence of IoT- evolution of IoT, IoT networking components ,IoT network architecture and design-comparing IoT architectures, simplified IoT architecture,Smart objects: the things in IoT-sensors, actuators and smart objects, sensor networks

Module 2: 8 hours

IoT protocols and Software: Connecting smart objects: communications criteria, IoT connectivity technologies(IEEE 802.15.4, Zigbee,Sigfox,LoRA,NB-IoT,Wi-Fi,Bluetooth),IoT communication technologies: infrastructure protocols (Ipv6,6LoWPAN), Data protocols (MQTT,CoAp, AMQP, XMPP, SOAP, REST, WebSocket)

Module 3: 8 hours

Introduction to Cloud computation and Big data analytics: cloud computing: introduction, cloud models, cloud implementation-cloud simulation,open source cloud (OpenStack),commercial cloud:AWS,introduction to data analytics for IoT, machine learning, Big data analytics tools and technology – Hadoop,Edge streaming analytics,Network analytics.

Module 4: 8 hours

IoT security: common challenges in IoT security,fundamentals of cryptography: cryptographic algorithms and their security services, the lightweight features of cryptographic algorithms, Quadruple Trust Model for IoT-A – Threat Analysis and model for IoT-A, Cloud security.

Module 5: 8 hours

IoT application and its Variants: Case studies: IoT for smart cities, health care, agriculture, smart meters.M2M, Web of things, Cellular IoT, Industrial IoT, Industry 4.0, IoT standards.

Course Plan

No	Topic	No. of Lectures
1	**Introduction to IoT:**	
1.1	Basics of Networking- network types,layered network models, addressing,TCP/IP Transport layer	2
1.2	Emergence of IoT- evolution of IoT,IoT networking components	3
1.3	IoT network architecture and design-comparing IoT architectures,simplified IoT architecture.	2
1.4	Smart objects: the things in IoT-sensors, actuators and smart objects,sensor networks	1
2	**IoT protocols and Softwares:**	
2.1	Connecting smart objects: communications criteria	2
2.2	IoT connectivity technologies(IEEE 802.15.4,Zigbee,Sigfox,LoRA,NB-IoT,Wi-Fi,Bluetooth)	3
2.3	IoT communication technologies: infrastructure protocols(IPv6,6LoWPAN),Data protocols(MQTT,CoAp,AMQP,XMPP,SOAP,REST,WebSocket)	3
3	**Introduction to Cloud computation and Big data analytics:**	
3.1	cloud computing: introduction, cloud models	1
3.2	cloud implementation-cloud simulation,open-source cloud(OpenStack), commercial cloud:AWS	2
3.3	introduction to data analytics for IoT, machine learning	1
3.4	Big data analytics tools and technology - Hadoop	2
3.5	Edge streaming analytics, Network analytics	2
4	**IoT security:**	
4.1	common challenges in Iot security	1
4.2	fundamentals of cryptography: cryptographic algorithms and their security services, the lightweight features of cryptographic algorithms	2
4.3	Quadruple Trust Model for IoT-A – Threat Analysis and model for IoT-A,	2
4.4	Cloud security	3
5	**IoT application and its Variants:**	

5.1	Case studies: IoT for smart cities, health care, agriculture, smart meters.	3
5.2	M2M, Web of things, Cellular IoT	3
5.3	Industrial IoT, Industry 4.0, IoT standards.	2

Text Books

1. S.Misra, A. Mukherjee, and A.Roy, 2020. Introduction to IoT. Cambridge University Press.
2. David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Rob Barton and Jerome Henry, —IoT Fundamentals: Networking Technologies, Protocols and Use Cases for Internet of Things, Cisco Press, 2017.
3. Rajkamal, "Internet of Things : Architecture and Design Principles", McGraw Hill (India) Private Limited
4. Chuan Kun Wn,"Internet of Things Security: Architectures and Security Measures",Springer 2021.
5. Alessandro Bassi, Martin Bauer, Martin Fiedler, Thorsten Kramp, Rob van Kranenburg, Sebastian Lange, Stefan Meissner, "Enabling things to talk – Designing IoT solutions with the IoT Architecture Reference Model", Springer Open, 2016

Reference Books

1. Jan Holler, Vlasios Tsiatsis, Catherine Mulligan, Stamatis Karnouskos, Stefan Avesand, David Boyle, "From Machine to Machine to Internet of Things", Elsevier Publications, 2014.
2. LuYan, Yan Zhang, Laurence T. Yang, Huansheng Ning, The Internet of Things: From RFID to the Next-Generation Pervasive Network, Aurbach publications, March,2008.
3. Vijay Madisetti , Arshdeep Bahga, Adrian McEwen (Author), Hakim Cassimally "Internet of Things A Hands-on-Approach" Arshdeep Bahga & Vijay Madisetti, 2014.
4. Asoke K Talukder and Roopa R Yavagal, "Mobile Computing," Tata McGraw Hill, 2010.
5. Barrie Sosinsky, "Cloud Computing Bible", Wiley-India, 2010
6. RonaldL. Krutz, Russell Dean Vines,Cloud Security: A Comprehensive Guide to Secure Cloud Computing,Wiley-India, 2010

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
221EEC023	OPTIMIZATION TECHNIQUES	PROGRAM ELECTIVE 2	3	0	0	3

Preamble: This course aims to enable the students to apply suitable optimization techniques for various applications.

Prerequisite: Nil

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

CO1	Outline the mathematical building blocks of optimization
CO2	Model and solve linear programming problems
CO3	Apply principles and techniques for solving nonlinear programming models
CO4	Investigate and assess constrained convex optimization problems
CO5	Appreciate prominent heuristic optimization algorithms
CO 6	Solve optimization problem through optimization software

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3		2	3	3	1	
CO2	3	1	2	3	3	1	1
CO3	3	1	2	3	3	1	1
CO4	3	1	2	3	3	1	1
CO5	3		2	3	3	1	1
CO 6	3	1	2	3	3	1	1

Assessment Pattern

Bloom's Category	End Semester Examination
Apply	30
Analyze	20
Evaluate	10
Create	

Mark distribution

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

Continuous Internal Evaluation Pattern:

- Preparing a review article based on peer reviewed original publications (minimum 10 publications shall be referred): *15 marks*
- Course based Task/ Seminar/ Data: *15 marks*
- Test paper 1 no. (Test paper shall include minimum 80% of syllabus):*10marks*

End Semester Examination Pattern:

The end semester examination will be conducted by 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 (such questions shall be useful in the testing of knowledge, skills, comprehension, application, analysis, synthesis, evaluation and understanding of the students). 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.

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 %.*

SYLLABUS

Module 1:

Mathematical Background:

Vector norm, Matrix norm, Inner product, Norm ball, Interior point, Closure and boundary, Complement, scaled sets, and sum of sets, Supremum and infimum, Vector subspace, Function, Continuity of function, Derivative and gradient, Hessian, Convex sets and convex functions. Introduction to optimization - Optimal problem formulation, Engineering applications of optimization, Optimization techniques - Classification.

Module 2:

Linear Programming:

Linear Programming - Formulation of the problem, Graphical method, Simplex method, Artificial variable techniques, Duality Principle, Dual simplex method.

Module 3:

Non-linear programming:

Unimodal Function, Elimination methods – Fibonacci method, Golden section method, Direct search methods – Random walk, Grid search method, Indirect search methods – Steepest descent method, Newton’s method.

Module 4:

Convex optimization:

Standard form of convex optimization problems, Global optimality, An optimality criterion for differentiable convex function, Lagrange dual function and conjugate function, Lagrange dual problem, Karush–Kuhn–Tucker (KKT) optimality conditions, Lagrange dual optimization.

Module 5:

Optimization algorithms:

Genetic algorithm, Neural network-based optimization, Ant colony optimization, Particle swarm optimization. Optimization Libraries in Python: scipy.optimize, CVXPY, CVXOPT.

Text Books

1. Chong-Yung-Chi, Wei-Chiang Li, Chia-Hsiang Lin, Convex Optimization for Signal Processing and Communications – From fundamentals to applications, CRC press.
2. Sukanta Nayak, Fundamentals of Optimization Techniques with Algorithms, Academic press.
3. Singiresu S. Rao, Engineering Optimization: Theory and Practice, John Wiley and Sons.

Reference Books

1. Igor Griva, ArielaSofer, Stephen G Nash,Linear and Nonlinear Optimization, Second edition, SIAM.
2. Kalyanmoy Deb,Optimization for Engineering: Design Algorithms and Examples, Second edition,Prentice Hall.
3. David G Luenberger, Linear and Nonlinear Programming, Second edition, Addison-Wesley.

No	Topic	No. ofLectures
1	**Mathematical Background:**	
1.1	Vector norm, Matrix norm, Inner product, Norm ball	1
1.2	Interior point, Closure and boundary	1
1.3	Complement, scaled sets, and sum of sets, Supremum and infimum	1
1.4	Vector subspace, Function, Continuity of function,	1
1.5	Derivative, gradient and Hessian	1
1.6	Convex sets and convex functions	1
1.7	Introduction to optimization - Optimal problem formulation	1
1.8	Engineering applications of optimization, Optimization techniques Classification	1
2	**Linear Programming:**	
2.1	Linear Programming - Formulation of the problem, Graphical method	2
2.2	Simplex method	2
2.3	Artificial variable techniques, Duality Principle	2
2.4	Dual simplex method	2
3	**Non-linear programming:**	

3.1	Uni-modal Function	1
3.2	Elimination Methods: (1) Fibonacci Method	1
3.3	Elimination Methods: (2) Golden Section Method	1
3.4	Direct Search Methods: (1) Random Walk	1
3.5	Direct Search Methods: (2) Grid Search Method	1
3.6	Indirect Search Method: (1) Steepest Descent Method	1
3.7	Indirect Search Method: (2) Newton's Method	2
4	**Convex optimization:**	
4.1	Standard form of convex optimization problems	1
4.2	Global optimality, An optimality criterion for differentiable convex function	2
4.3	Lagrange dual function and conjugate function	1
4.4	Lagrange dual problem	2
4.5	Karush–Kuhn–Tucker (KKT) optimality conditions	2
5	**Optimization algorithms:**	
5.1	Genetic algorithm	1
5.2	Neural network-based optimization	2
5.3	Ant colony optimization	2
5.4	Particle swarm optimization.	1
5.5	Optimization Libraries in Python: scipy.optimize, CVXPY, CVXOPT	2

Model Question paper

ELECTRONICS AND COMMUNICATION-EC3

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

FIRST SEMESTER M. TECH DEGREE EXAMINATION

Electronics and Communication Engineering

Streams: Signal Processing, Signal Processing and Embedded Systems, Communication Engineering & Signal Processing

Course Code and Course Name: 221EEC023 Optimization Techniques

Max.Marks: 60 Duration:2.5 Hours

PARTA

Answer ALL Questions. Each Carries 5 marks.

1. Define the gradient of the function. Demonstrate its importance in the multi-variable optimization
2. State and prove complementary slackness theorem.
3. Using Newton's method minimize $f=(3x_1-1)^3 + 4x_1x_2 + 2x_2^2$ by taking initial point as (1,2)
4. State and prove Kuhn – Tucker conditions in non-linear programming
5. Differentiate supervised and supervised learning.

PART–B

Answer any FIVE full questions; each question carries 7 marks.

6.a) Given, $\Psi_1^{-1} = \begin{bmatrix} 0.5000 & 0.5000 & 0.5000 & 0.5000 \\ 0.6533 & 0.2706 & -0.2706 & -0.6533 \\ 0.5000 & -0.5000 & -0.5000 & 0.5000 \\ 0.2706 & -0.6533 & 0.6533 & -0.2706 \end{bmatrix}$,

$\Psi_2^{-1} = \begin{bmatrix} 1 & 1 & 1 & 1 \\ 1 & -jj & -1 & jj \\ 1 & -1 & 1 & -1 \\ 1 & jj & -1 & -jj \end{bmatrix}$ and $x = \begin{bmatrix} 4 \\ 5 \\ 5 \\ 4 \end{bmatrix}$ 4 marks

Let Ψ_1 and Ψ_2 be two change of basis matrices. Obtain the representation of the given vector x in terms of Ψ_1 and Ψ_2. Calculate l_0, l_1 and l_∞ norms of the representation.

6.b) Discuss the convexity and concavity of the following functions

a) $ff(x) = (x_1 + x_2)e^{(x_1+x_2)} x_1 > 0, x_2 > 0$

b) $ff(x) = x_1 ff_1(x) + x_2 ff_2(x) x_1 \geq 0, x_2 \geq 0$ and both $ff_1(x)$ and $ff_2(x)$ are convex functions 3 marks

7.a) Congratulations! Upon graduating from college, you have immediately been offered a high-paying position as president of the Lego Furniture Company. Your company produces chairs (each requiring 2 square blocks and 1 rectangular block) as well as tables (each requiring 2 square blocks and 2 rectangular blocks) and has available resources consisting of 8 rectangular 3 marks

blocks and 6 square ones. Assume chairs and tables each sell for 5 and 7 respectively, and that your company sells all of what it produces.

(i) Set up an LP whose objective is to maximize your company's revenue.

(ii) Represent it in the standard form and matrix form.

7.b) Solve the following LPP using dual simplex method

$$\min z = 3x_1+2x_2$$

subject to $2x_1+ 3x_2 \geq 30$

$-x_1+2x_2 \leq 6$

$x_1+3x_2 > 20$

$x_1, x_2 \geq 0$

4 marks

8a) Solve the following optimization problem using Simplex algorithm. 3 marks

$$\max_{x_1,\, x_2,\, x_3} \; 15x_1 + 4x_2 - 5x_3$$
$$s.t. \quad x_1 + x_2 - x_3 \leq 21$$
$$3x_1 + 2x_2 + 2x_3 \leq 42$$
$$2x_1 + 3x_3 \leq 42$$
$$x_1 \geq 0,\; x_2 \geq 0, x_3 \geq 0$$

8 b) Consider an LPP 4 marks

$$\max z = -x_1 - x_2$$

subject to $-x_1+ x_2 \geq 1$

$2x_1- x_2 \leq 2$

$x_1, x_2 \geq 0$

Find the dual to the problem. Solve the primal and the dual graphically, and verify that the results of the strong duality theorem hold.

9a) Prove that in Fibonacci search algorithm, at the end of (n-1) iterations, the length of the interval of uncertainty is reduced from (b_1-a_1) to $(b_1-a_1) / F_n$. Moreover, show that Fibonacci method is more efficient than Golden section search algorithm. 4 marks

9 b) Use Newton's method to solve, 3 marks

minimize $ff(x_1,x_2) = 5x_1^4+6x_2^4-6x_1^2+2x_1x_2+5x_2^2+15x_1-7x_2+13$

Use the initial guess $(1, 1)^T$.

10a) Use the steepest descent method to solve 4 marks

minimize $ff(x_1,x_2) = 4x_1^2+4x_1x_2+2x_2^2-3x_1$, starting from the point $(2, 2)^T$.

Perform three iterations.

10 b) Describe Grid search method with a suitable example. 3 marks

11a) Consider the problem 4 marks

min $ff(x_1,x_2,x_3,x_4) = x_1^2+x_2^2+x_3^2+x_4^2$

subject to $g_1(x_1,x_2,x_3,x_4) = x_1+2x_2+3x_3+5x_4-10 = 0$

$g_2(x_1,x_2,x_3,x_4) = x_1+2x_2+5x_3+6x_4-15 = 0$

Solve the problem using Lagrangian method and compute the Lagrange multipliers.

11 b) Formulate the Karush-Kuhn-Tucker (KKT) necessary conditions for the following optimization problem 3 marks

$$\begin{aligned} \min \quad & z = x_1 + x_2 \\ \text{subject to} \quad & g_1(x_1,x_2) = x_1^3 - x_2 \geq 0 \\ & g_2(x_1,x_2) = x_1 \geq 0 \\ & g_3(x_1,x_2) = x_2 \geq 0 \end{aligned}$$

12 a) Explain Ant Colony Optimization algorithm in detail. 4 marks

12 b) Describe Particle Swam Optimization algorithm. List out its advantages, disadvantages and applications. 3 marks

SEMESTER II

Discipline : Electronics and Communication Engineering
Stream : EC3

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
222TEC100	FOUNDATIONS OF DATA SCIENCE	DISCIPLINE CORE 2	3	0	0	3

Preamble: Nil

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

CO 1	Understand the basics of machine learning and different types.
CO 2	Differentiate regression and classification, Understand the basics of unsupervised learning and non-metric methods
CO 3	Apply statistical methods in non-linear classification and neural networks
CO 4	Understand the basics of deep learning networks, convolutional neural networks

Mapping of course outcomes with program outcomes (1-3)

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

Mark distribution

Total Marks	CIE	ESE	ESE Duration
100	40	60	2.5 hours

Continuous Internal Evaluation Pattern:

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

End Semester Examination Pattern:
Total : 60 marks
Part A: Answer all – 5 questions x 5 marks : 25 marks
Part B: Answer 5 of 7: 5 questions x 7 marks : 35 marks

The end semester examination will be conducted by the University - 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 (such questions shall be useful in the testing of knowledge, skills, comprehension, application, analysis, synthesis, evaluation and understanding of the students). 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.

Model Question paper

Total: 60 marks

Part A (Answer all) 25 marks

1. Discuss different types of machine learning with examples. (5)
2. Differentiate regression and classification with examples (5)
3. How SVM is used for multiclass problem? (5)
4. Explain clustering with examples. (5)
5. Discuss different activation functions used in deep neural networks (5)

Part B (Answer any 5) 35 marks

6. Explain the terms features, training set, target vector, test set, and curse of dimensionality in machine learning. (7)
7. Show that the Bayesian classifier is optimal with respect to minimizing the classification error probability. (7)
8. Give a step by step description of the perceptron algorithm in classification. (7)
9. Obtain the cost function for optimization in SVM for separable classes. (7)
10. Describe convolutional neural networks with detailed description of each layers (7)
11. Obtain the decision surface for an equi-probable two class system, where the probability density functions of n-dimensional feature vectors in both classes are normally distributed. (7)
12. Explain the principle of back propagation neural networks with neat architecture diagram (7)

Syllabus and Course Plan (total hours: 37)

No	Topic	hours
1	**8 hours**	
1.1	Basics of machine learning, supervised and unsupervised learning,examples,	2
1.2	features, feature vector, training set, target vector, test set	1
1.3	over-fitting, curse of dimensionality.	1
1.4	Evaluation and model selection: ROC curves, evaluation measures,	2
1.5	validation set, bias-variance trade-off.	1
1.6	confusion matrix, recall, precision, accuracy.	1
2	**7 hours**	
2.1	Regression: linear regression, error functions in regression	1
2.2	multivariate regression, regression applications, bias and variance.	1
2.3	Classification : Bayes' decision theory,	2
2.4	discriminant functions and decision surfaces,	1
2.5	Bayesian classification for normal distributions, classification applications.	2
3	**7 hours**	
3.1	Linear discriminant based algorithm: perceptron, perceptron algorithm,	1
3.2	support vector machines.	2
3.3	Nonlinear classifiers, the XOR problem,	2
3.4	multilayer perceptrons,	1
3.5	backpropagation algorithm.	1
4	**8 hours**	
4.1	Unsupervised learning:	1
4.2	Clustering, examples, criterion functions for clustering,	2
4.3	proximity measures, algorithms for clustering.	1
4.4	Ensemble methods: boosting, bagging.	2
4.5	Basics of decision trees, random forest, examples.	2
5	**7 hours**	
5.1	Introduction to deep learning networks,	1
5.2	deep feedforward networks,	2
5.3	basics of convolutional neural networks (CNN)	2
5.4	CNN basic structure, Hyper-parameter tuning, Regularization - Dropouts,	1
5.5	Initialization, CNN examples	1

Reference Books

1. Bishop, C. M. "Pattern Recognition and Machine Learning" Springer, New York, 2006.
2. Theodoridis, S. and Koutroumbas, K. "Pattern Recognition". Academic Press, San Diego, 2003.
3. Hastie, T., Tibshirani, R. and Friedman, J. "The Elements of Statistical Learning". Springer.

4. Duda, R.O., Hart, P.E., and Stork, D.G. “Pattern Classification”. Wiley, New York,

5. Ian Goodfellow, Yoshua Bengio, Aaron Courville. “Deep Learning” MIT Press, 2016

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
222TEC002	ESTIMATION AND DETECTION THEORY	PROGRAM CORE 3	3	0	0	3

Preamble: This course introduces the basics of estimation and detection theory,with a focus on classical and Bayesian estimators, estimation bounds, hypothesis testing, and detectors of signals in noise.

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

CO 1	Recognize, describeand evaluatetwo broad areas of statistical inference namely, estimationand detection.
CO 2	Compute the performance limits of unbiased estimators and compare the performance of a given estimator to these bounds
CO 3	Analyse the performances ofclassical and Bayesian estimation techniques,when applied for solving parameter estimation problems from noisy data.
CO 4	Apply optimal hypothesis tests and analyse the performance of these tests for signal detection from noisy data.
CO 5	Relate real world applications to different types of inference problems and identify appropriate tools for approaching these problems and communicating them via presentations/reports/publications .

Mapping of course outcomes with program outcomes

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

Assessment Pattern

Bloom's Category	CIE	End Semester Examination
Apply	10	30
Analyse	10	15
Evaluate	10	15
Create	10	

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.

End Semester Examination: 60 marks

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 (such questions shall be useful in the testing of knowledge, skills, comprehension, application, analysis, synthesis, evaluation and understanding of the students), with 1 question from each module, having 5 marks for each question. Students shall answer all questions. Part B contains 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 shall answer any five. Each question can carry 7 marks. Total duration of the examination will be 150 minutes.

Model Question Paper

Course Code: 222TEC002

Course Name: ESTIMATION AND DETECTION THEORY

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

PART A

Answer all Questions. Each question carries 5 marks

1.Define Unbiased Estimators ?Find an unbiased estimator for estimating a DC level in white Gaussian noise considering the observations $x[n] = A + w[n],\ n = 0,1,\dots N-1$ where, $w[n]$ is white Gaussian noise and A is the parameter to be estimated.

2.We observe $x[n] = A + w[n],\ n = 0,1,\dots N-1$ where, $w[n]$ is white noise with variance σ^2 (and is of unspecified PDF). Find the Best Linear Unbiased Estimator (BLUE) for estimating the DC level, .

3. Derive the expression for minimum Least squares error in Linear Least squares estimation approach for a scalar parameter.

4.We observe the IID samples $x[n]$ for n = 0,1,…,N-1 from the Rayleigh PDF

$p(x[n]) = \frac{x[n]}{\sigma^2} exp\left(-\frac{1}{2}\frac{x^2[n]}{\sigma^2}\right)$.

Derive the NP test for the hypothesis testing problem

$$\mathcal{H}_0:\ \sigma^2 = \sigma_0^2\ ,\qquad \mathcal{H}_1 : \sigma^2 = \sigma_1^2 > \sigma_0^2$$

5.It is desired to detect a known deterministic signal in white Gaussian Noise. How do you decide upon a suitable detector for this case?

PART B

Answer any one full question from each module.

Each question carries 7 marks

6.(a) State the CRLB theorem for scalar parameter. (2)

(b) If$x[n] = r^n + w[n], for\ n = 0,1,\dots.N-1$, are observed, where $w[n]$ is WGN with variance σ^2 and r is to be estimated, find the CRLB. Does an efficient estimator exist and if so find its variance. (5)

7. (a)Illustrate a method for finding sufficient statistics. (3)

(b) The IID observations$x[n]\ for\ n = 0,1,\dots.N-1$, are distributed according to $\mathcal{N}(\theta,\theta), where\ \theta > 0$. Find a sufficient statistic for θ . (4)

8.(a) For the received data $x[n] = A + w[n], for\ n = 0,1, \ldots . N-1$, where A is the unknown DC level to be estimated and $w[n]$is WGN with known variance σ^2, find MLE of A. (3)

(b) Prove the statement: If an efficient estimator exists, the maximum likelihood method will produce it.(Hint: Assuming a scalar parameter, if an efficient estimator exists, then we have $\frac{\partial \ln p(\boldsymbol{x}|\theta)}{\partial \theta} = I(\theta)(\hat{\theta} - \theta)$). (4)

9.Assume that $p(x[n]|\theta) = \begin{cases} \theta \exp(-\theta x[n]) & x[n] > 0 \\ 0 & x[n] < 0 \end{cases}$

where the $x[n]'s$ are conditionally IID, or $p(\boldsymbol{x}|\theta) = \prod_{n=0}^{N-1} p(x[n]|\theta)$

and the prior PDF is $p(\theta) = \begin{cases} \lambda \exp(-\lambda\theta) & \theta > 0 \\ 0 & \theta < 0 \end{cases}$ (7)

Find the MAP estimator for θ.

10.We have the detection problem

$$\mathcal{H}_0: x[n] = w[n] \qquad n = 0,1, \ldots, N-1$$

$$\mathcal{H}_1: x[n] = A + w[n] \quad n = 0,1, \ldots, N-1$$

where $A > 0$ and $w[n]$ is WGN with variance σ^2. Assume that $P(\mathcal{H}_0) = P(\mathcal{H}_1) = \frac{1}{2}$. Determine the minimum probability of error. (7)

11.We model the signal as a zero mean, white, WSS Gaussian random process with varianceσ_s^2,where the noise $w[n]$,is assumed to be WGN with variance σ^2. Suggest a suitable detector for this scenario with reasons for the choice.(7)

12. Derive the expressions for the mean and covariance of the Gaussian Posterior PDF for Bayesian General Linear Model. (7)

Syllabus and Course Plan

Module 1: **Parameter Estimation: Minimum variance unbiased estimation, Cramer-Rao lowerBound and Linear Models**

Review of Linear Algebra and Random Processes, Estimation in Signal Processing; Minimum variance unbiased estimation: Minimum variance criterion; existence of minimum variance unbiased estimator; generalization to vector parameters,Cramer-Rao lower bound: scalar parameters; signal in white Gaussian noise; vector parameters; transformations; general Gaussian case;wide-sense stationary Gaussian processes;Examples from radar, sonar, and speech processing,Linear models: definition and properties; curve fitting; Fourier analysis; system identification; general linear models

Module 2:**General minimum variance unbiased estimation and Best linear unbiased estimators**

General minimum variance unbiased estimation: sufficient statistic; Finding minimum variance unbiased estimators; complete statistics; generalizations,Best linear unbiased estimators: definition; finding the BLUE; example of source localization; generalization to vector parameters.

Module 3:**Maximum likelihood estimators,Linear Least Squares Approach and Bayesian Estimators**

Maximum likelihood estimators: definition; finding the MLE; properties; transformed parameters; vector parameters; examples,Linear Least Squares Approach for Gaussian linear models,Bayesian estimators: priors; posteriors;linear models; Bayes Risks,Minimum Mean Square Error Estimator, Maximum A-Posteriori estimator,State estimation: Kalman Filters

Module 4:**Basics of Statistical Detection Theory**

Simple hypothesis testing;Neyman-Pearson detectors, Minimum probability of error,Minimum Bayes risk detectors; receiver operating characteristics; Multiplehypothesis testing,Composite hypothesis testing: Generalized Likelihood Ratio Test- Detection of signals with Unknown Amplitude.

Module 5:**Detection of signals in noise**

Detection of known signals in noise: Matched filter; performance of matched filter; generalized matched filter; Minimum distance detector; examples from communications, radar/sonar, and pattern recognition,Detection of random signals: energy detector; estimator-correlator; canonical form of detector; performance analysis; examples.

No	Topic	No. of Lectures
1	**Parameter Estimation: Minimum variance unbiased estimation, Cramer-Rao lowerBound and Linear Models**	
1.1	Review of Linear Algebra and Random Processes, Estimation in Signal Processing;Minimum variance unbiased estimation: Minimum variance criterion; existence of minimum variance unbiased estimator; generalization to vector parameters	3
1.2	Cramer-Rao lower bound: scalar parameters; signal in white Gaussian noise; vector parameters; transformations; general Gaussian case;wide-sense stationary Gaussian processes;Examples from radar, sonar, and speech processing	3
1.3	Linear models: definition and properties; curve fitting; Fourier analysis; system identification; general linear models	2
2	**General minimum variance unbiased estimation and Best linear unbiased estimators**	
2.1	General minimum variance unbiased estimation:sufficientstatistic;Finding minimum variance unbiased estimators; complete statistics; generalizations	3
2.2	Best linear unbiased estimators: definition; finding theBLUE;example ofsourcelocalization; generalization to vectorparameters	4
3	**Maximum likelihood estimators,Linear Least Squares Approach and Bayesian Estimators**	
3.1	Maximum likelihood estimators: definition; finding the MLE; properties; transformed parameters; vector parameters; examples	2
3.2	Linear Least Squares Approach for Gaussian linear models	1
3.2	Bayesian estimators: priors; posteriors;linear models; Bayes Risks,Minimum Mean Square Error Estimator, Maximum A-Posteriori estimator.	4
3.3	State estimation: Kalman Filters	2
4	**Basics of Statistical Detection Theory**	
4.1	Simple hypothesis testing;Neyman-Pearson detectors, Minimum probability of error	3
4.2	Minimum Bayes risk detectors; receiver operating characteristics; Multiple hypothesis testing,	3
4.3	Composite hypothesis testing : Generalized Likelihood Ratio Test- Detection of signals with Unknown Amplitude.	2
5	**Detection of signals in noise**	
5.1	Detection of known signals in noise: Matched filter ;performance of matched filter; generalized matched filter; Minimum distance detector; examples from	4

	communications, radar/sonar, and pattern recognition	
5.2	Detection of random signals: energy detector; estimator-correlator; canonical form of detector; performance analysis; examples.	4

Text Books

1. S.M. Kay, Fundamentals of Statistical Signal Processing: Detection Theory, Prentice Hall, 1998

2. S.M. Kay, Fundamentals of Statistical Signal Processing: Estimation Theory, Prentice Hall, 1993

Reference Books

1. H.L. Van Trees, Detection, Estimation and Modulation Theory, Part I, Wiley, 1968.

2. H.V. Poor, An introduction to Signal Detection and Estimation, 2nd edition, Springer, 1994.

3. L.L. Scharf, Statistical Signal Processing, Detection and Estimation Theory, Addison-Wesley,1990

COURSE CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
222PEC100	MINI PROJECT	PROJECT	0	0	4	2

Mini project can help to strengthen the understanding of student's fundamentals through application of theoretical concepts and to boost their skills and widen the horizon of their thinking. The ultimate aim of an engineering student is to resolve a problem by applying theoretical knowledge. Doing more projects increases problem solving skills.

The introduction of mini projects ensures preparedness of students to undertake dissertation. Students should identify a topic of interest in consultation with PG Programme Coordinator that should lead to their dissertation/research project. Demonstrate the novelty of the project through the results and outputs.The progress of the mini project is evaluated based on three reviews, two interim reviews and a final review. A report is required at the end of the semester.

Evaluation Committee - Programme Coordinator, One Senior Professor and Guide.

Sl. No	Type of evaluations	Mark	Evaluation criteria
1	Interim evaluation 1	20	
2	Interim evaluation 2	20	
3	Final evaluation by a Committee	35	Will be evaluating the level of completion and demonstration of functionality/ specifications, clarity of presentation, oral examination, work knowledge and involvement
4	Report	15	the committee will be evaluating for the technical content, adequacy of references, templates followed and permitted plagiarism level(not more than 25%)
5	Supervisor/Guide	10	
	Total Marks	100	

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
222LEC001	SIGNAL PROCESSING LAB II	LABORATORY 2	0	0	2	1

Preamble: This labis envisaged as a specialization lab for the streams: Signal Processing, Communication Engineering & Signal Processing, and Signal Processing and Embedded Systems

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

CO 1	Apply knowledge of Advanced Signal Processing, Image Processing,Deep learning, Communication Engineering and Embedded systems in various signal processing applications.
CO 2	Develop the student's ability on analysing observations of experiments/ simulations, interpreting them and preparing reports
CO 3	Implement the fundamental principlesand algorithmslearned inSignal Processing/Communication Engineering/ Embedded systems

Assessment Pattern

Bloom's Category	CIE
Apply	50
Analyse	30
Evaluate	10
Create	10

Mark distribution

Total Marks	CIE	ESE
100	100	--

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.

Tools :

Numerical Computing Environment – MATLAB or any other equivalent tool.

Based on the specialization of the streams, experiments must be chosen mandatorily from **ANYONE** of the sets listed below:

Set I(Specialization: Signal Processing**)**
Set II (Specialization: Communication Engineering and Signal Processing)
Set III (Specialization: Signal Processing and Embedded systems).

Syllabus

No	Topics
Set I	**Speech, Image and Deep Learning Lab**
1	Image processing fundamentals-Simulation and Display of an Image, Negative of an Image- Implementation of Relationships between Pixels Geometric transformations- Image rotation, scaling, and translation
2	Apply 2 D DFT, DCT and DWT transform for an image and compare the results
4	Image enhancement-Point/spatial/transform operations Enhance an image using image arithmetic and logical operations--- Gray level slicing/Sharpening/histogram equalization/Filtering/homomorphic filtering
5	Colour image processing --Wavelet-based Image Processing.
6	Image Segmentation
7	Edge detection-basic edge detection methods- parametric and non-parametric approaches Morphological operations -dilation, erosion.
8	Object recognition in an image Template matching/ clustering
9	Feature extraction from speech Implement the steps for the extraction of MFCC/rhythmic features from a given audio file Visualization of spectrogram/Mel-spectrogram---narrow-band and wide-band spectrogram
10	Implement the steps to extract LPC coefficient from the given speech file
11	Implement the steps to extract formants using homographic filtering
12	Pattern classification using machine learning/Deep learning, Implementation of KNN, K-Means Clustering, Implementation of Logistic Regression, SVM (*speech or image data)* Deep learning architectures using TensorFlow/Keras*(speech or image data)*
Set II.	**Communication Engineering**
1	Simulation of probability Distributions- Continuous and Discrete. -Illustration of Central Limit theorem.

2	Simulation of PAM and PCM systems and performance evaluation.
3	Implementation of digital modulation schemes-BASK,BFSK, BPSK. Plot BER vsE_b/N_0 in AWGN channel.
4	Implementationand performance comparison of QPSK , DPSK, MSK& GMSK.
5	Plotting Eye pattern and Constellation diagram of various digital modulation schemes
6	Implementation of Matched filter, Correlation receiver.
7	Communication over fading Channels-Rayleigh fading & Rician fading
8	Simulation of RAKE receiver.
9	Spread spectrum communication systems-Develop simulation models for Direct sequence Spread spectrum systems and Frequency Hopping spread spectrum systems.
10.	Simulation of OFDM system.
Set III.	**Embedded Systems**
A	***FPGA based experiments:***
1	Design entry using Verilog/ VHDL examples for circuit description.
2	Sequential and concurrent statements.
3	Structural and behavioral descriptions, principles of operation and limitation of HDL simulators.
4	Examples of sequential and combinational logic design and simulation.
5	Test vector generation.
6	Synthesis principles, logical effort, standard cell-based design and synthesis, interpretation synthesis scripts, constraint introduction and library preparation and generation.
7	FPGA programming
8	I/O interfacing
9	Analog interfacing
10	Real time application development.
B	***Microcontroller based Experiments*:**
1	Design with ARM Processors: I/O programming, ADC/DAC, Timers, Interrupts.
2	Study of one type of Real Time Operating Systems (RTOS)

SEMESTER II

PROGRAM ELECTIVE III

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
222EEC012	WIRELESS SENSOR NETWORKS	PROGRAM ELECTIVE 3	3	0	0	3

Preamble: The core modules of this elective course include introduction to wireless sensor networks, localisation and synchronisation techniques, wireless MAC protocols, routing in wireless sensor networks and fundamentals of network security. This course aims to teach the student to understand the concepts of wireless sensor networks.

Course prerequisites: NIL

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

CO 1	Evaluate the performance of schedule based and random Medium Access Control protocols for power consumption, fairness, channel utilization and control packet overhead.
CO 2	Evaluate the performance of Geographic routing protocols for power consumption, scalability and latency parameters.
CO 3	Relate the performance of transport control protocols for congestion detection and avoidance, reliability and control packet overhead parameters.
CO 4	Understand about the routing challenges in WSN.
CO 5	Classify the security issues in wireless network.

Mapping of course outcomes with program outcomes

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

Assessment Pattern

Bloom's Category	End Semester Examination (Marks)
Apply	20

Analyse	20
Evaluate	20
Create	

Mark distribution

Total Marks	CIE	ESE	ESE Duration
100	40	60	2.5 hours

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

Continuous Internal Evaluation Pattern:

Continuous Internal Evaluation: 40 marks
Preparing a review article based on peer reviewed original publications (minimum 10 publications shall be referred): 15 marks
Course based task/Seminar/Data collection and interpretation: 15 marks
Test paper, 1 no.: 10 marks
Test paper shall include minimum 80% of the syllabus.

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 (such questions shall be useful in the testing of knowledge, skills, comprehension, application, analysis, synthesis, evaluation and understanding of the students). 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.

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 %.

Model Question Paper

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

SECOND SEMESTER M. TECH DEGREE EXAMINATION

Program: M.Tech. in EC3 (Signal Processing, Signal Processing & Embedded Systems, Communication Engineering & Signal Processing)

Course Code: 222EEC012

Course Name: WIRELESS SENSOR NETWORKS

Max. Marks: 60 Duration: 150 Minutes

PART A

Answer ALL Questions. Each Carries 5 mark.

1. The communication subsystem of a wireless sensor node is usually interfaced with the processor subsystem through a SPI bus instead of an I2C bus. Why is this?
2. What are the advantages and disadvantages of contention-free and contention-based medium access strategies? Can you think of scenarios where one would be preferable over the other?
3. Why is time synchronization needed in a WSN? Name at least three concrete examples.
4. What is the concept behind hierarchical routing and what advantages does it have over other techniques?
5. Why is it necessary to provide the opportunity to dynamically reprogram a sensor network? What is challenging in distributing a new program to all sensor nodes in the network?

PART B

Answer any 5 questions: Each question carries 7 marks

6. Explain the architecture of wireless sensor node with neat diagram.
7. The five requirements of MAC protocols for wireless sensor networks are energy efficiency, scalability, adaptability, low latency, and reliability. Can you describe a concrete WSN application for each of these five requirements, where the requirement would be more important than the others?

8. How does the S-MAC protocol reduce the duty cycles of sensor nodes? How does the S-MAC protocol attempt to reduce collisions? How does it address the hidden-terminal problem? Name at least three disadvantages of the S-MAC protocol.

9. Explain the concept behind the RBS protocol. How can RBS be extended to work in multi-hop scenarios?

10. RSS-based localization techniques are often combined with a process called RF profiling, that is, the mapping of the effects of objects in the environment on signal propagation. Why is this necessary and can you think of examples of such objects?

11. What is the difference between a proactive routing protocol and a reactive routing protocol? Name at least two examples for each category. Consider the following WSN scenarios and explain why you would choose either a proactive or a reactive routing solution: (a) A WSN is used to monitor air pollution in a city where every sensor reports its sensor data once every minute to a single remote base station. Most sensors are mounted on lamp posts, but some are also mounted on city buses. (b) A WSN is used to measure humidity in a field, where low-power sensors report measurements only when certain thresholds are exceeded. (c) A WSN is used to detect the presence of vehicles, where each sensor locally records the times of vehicle detection. These records are delivered to the base station only when the sensor is explicitly queried.

12. Describe the CIA security model. Which services described in this model do you think are essential for the following scenarios? Justify your answers. (a) A WSN that allows emergency response teams to avoid risky and dangerous areas and activities. (b) A WSN that collects biometric information collected at an airport. (c) A WSN that measures air pollution in a city for a research study. (d) A WSN that alerts a city of an impending earthquake.

SYLLABUS

Module 1: 8 hours

Fundamentals of sensor networks: Introduction wireless sensor networks, Wireless Sensor nodes- Sensing and sensors challenges and constraints - node architecture-sensing subsystem, processor subsystem, communication interfaces-prototypes, Application of Wireless sensors,Introduction of Tiny OS Programming.

Module 2: 8 hours

Communication characteristics and deployment mechanisms: Basics of time synchronization-Time synchronization protocols - Localization- Ranging Techniques- Range based Localization-Range Free Localization- Event driven Localization

Module 3: 8 hours

MAC Layer: Overview-Wireless Mac Protocols-Characteristics of MAC protocols in Sensor networks – Contention free MAC Protocols- characteristics- Traffic Adaptive Medium Access-Y-MAC, Low energy Adaptive Clustering - Contention based MAC Protocols Power Aware Multi-Access with signalling, Sensor MAC-Timeout MAC-Data gathering MAC

Module 4: 8 hours

Routing in wireless sensor networks: Design Issues in WSN routing- Data Dissemination and Gathering-Routing Challenges in WSN - Flooding-Flat Based Routing – SAR, Directed Diffusion, Hierarchical Routing- LEACH, PEGASIS - Query Based Routing- Negotiation Based Routing- Geographical Based Routing.

Module 5: 8 hours

Middleware and security issues: WSN middleware principles-Middlewarearchitecture-Existing middleware - operating systems for wireless sensor networks-performance and traffic management - Fundamentals of network security-challenges and attacks.

Course Plan

No	Topic	No. of Lectures
1	**Fundamentals of sensor networks:**	
1.1	Introduction wireless sensor networks, Wireless Sensor nodes- Sensing and sensors challenges and constraints.	2
1.2	Node architecture-sensing subsystem, processor subsystem	3
1.3	Communication interfaces- prototypes, Application of Wireless sensors,Introduction of Tiny OS Programming	3
2	**Communication characteristics and deployment mechanisms:**	
2.1	Basics of time synchronization-Time synchronization protocols	3
2.2	Localization- Ranging Techniques- Range based Localization-	3
2.3	Range Free Localization- Event driven Localization	2
3	**MAC Layer:**	
3.1	Overview-Wireless Mac Protocols-Characteristics of MAC protocols in Sensor networks	2
3.2	Contention free MAC Protocols- characteristics- Traffic Adaptive Medium Access-Y-MAC, Low energy Adaptive Clustering	3
3.3	Low energy Adaptive Clustering - Contention based MAC Protocols Power Aware Multi-Access with signalling, Sensor MAC-Timeout MAC-Data gathering MAC	3
4	**Routing in wireless sensor networks:**	
4.1	Design Issues in WSN routing- Data Dissemination and Gathering	2
4.2	Routing Challenges in WSN - Flooding-Flat Based Routing – SAR, Directed Diffusion,	2
4.3	Hierarchical Routing- LEACH, PEGASIS - Query Based Routing- Negotiation Based Routing- Geographical Based Routing	3
5	**Middleware and security issues:**	
5.1	WSNmiddleware principles-Middleware architecture-Existing middleware	3
5.2	Operating systems for wireless sensor networks-performance and traffic management.	3
5.3	Fundamentals of network security-challenges and attacks	2

Text Books

1. DargieWaltenegus, Poellabauer Christian (2011): Fundamentals of Wireless Sensor Networks, Theory and Practice: Wiley Series on wireless Communication and Mobile Computing.
2. SohrabyKazem, Manoli Daniel (2010): Wireless Sensor networks-Technology, Protocols and Applications, New Jersey: Wiley Inter Science Publications.

Reference Books

1. Krishnamachari Bhaskar (2005): Networking Wireless Sensors, Cambridge: Cambridge University Press.
2. Raghavendra C.S., Sivalingam Krishna M., Taiebznati (2004): Wireless Sensor Networks: Springer Science.

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
222EEC013	IMAGE PROCESSING AND COMPUTER VISION	PROGRAM ELECTIVE 3	3	0	0	3

Preamble: Image processing is a method to perform certain operations on an image, in order to get an enhanced image or to extract some useful information from it. It is a type of signal processing in which input is an image and output may be image or characteristics/features associated with that image. Computer vision is a field of artificial intelligence (AI) that enables computers and systems to derive meaningful information from digital images, videos and other visual inputs — and take actions or make recommendations based on that information. Students will be able to learn image processing fundamentals, understand the different types of algorithms in image processing and computer vision, develop in-depth knowledge of image and video processing tasks such as image representation, image transforms, image enhancement, Image restoration, image segmentation and image compression.

Prerequisite: A sound knowledge of the fundamentals and basics of digital signal processing techniques.

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

CO 1	Understand and apply the fundamentals, concepts and terminologies in image processing and computer vision.
CO 2	Understand and analyse the principles of image restoration and segmentation and illustrate the methods and algorithms for image restoration and segmentation.
CO 3	Understand and analyse the principles of image compression and video processing and illustrate the methods and algorithms for image compression and video processing.
CO 4	Analyze and evaluate the performance of depth estimation and multi-camera views. for computer vision.
CO 5	Evaluate critically the techniques for motion analysis and optical flow in computer vision.

Mapping of course outcomes with program outcomes

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

Assessment Pattern

Bloom's Category	End Semester Examination
Apply	20 %
Analyse	40 %
Evaluate	20 %
Create	20 %

Mark distribution

Total Marks	CIE	ESE	ESE Duration
100	40	60	2.5 hours

Continuous Internal Evaluation: 40 marks

Preparing a review article based on peer reviewed

Original publications (minimum 10 Publications shall be referred): 15 marks

Course based task/Seminar/Data Collection and interpretation: 15 marks

Test paper, 1 no.: 10 marks

Test paper shall include minimum 80% of the syllabus. include minimum 80% of the syllabus.

End Semester Examination: 60 marks

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 (such questions shall be useful in the testing of knowledge, skills, comprehension, application, analysis, synthesis, evaluation and understanding of the students). 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.

Model Question paper

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

SECOND SEMESTER M.TECH DEGREE EXAMINATION, (**Model Question Paper)**

Discipline: ELECTRONICS & COMMUNICATION ENGINEERING

Stream: EC3 (Signal Processing, Signal Processing & Embedded Systems, Communication Engineering & Signal Processing)

Course Code: 222EEC013

Course Name: IMAGE PROCESSING AND COMPUTER VISION

Max. Marks: 60 Duration: 2.5Hours

PART A

Answer all Questions. Each Question Carries 5 marks.

1	Explain the properties of Fourier transform specific to image processing.	CO1	
2	Explain basic principles of LoG and DoG filters. Discuss the merits and demerits compared with other type of filters. Discuss the shape of LoG(x, y, σ) with an indicative plot.	CO1	
3	Explain the basic principles of transform coding. Give the block schematic of a transform coder. Compare the performance of different transforms based coders with a graph.	CO2	
4	Illustrate the concept of depth estimation. What is stereo dept estimation ?	CO2	
5	Comment on Phong Lighting Model. Why shading is important in computer vision? Disccuss Phong shading.	CO3	

PART – B

Answer any 5 full questions ; Each question carries 7 marks.

1. a)	Compare and contrast spatial and spectral domain processing of images. Discuss some applications that require these type of processing. Write a MATLAB program snippet	4	CO 1	

	for generating a checker box pattern of size 8 × 8.			
1. b)	Briefly explain edges in images. What do you mean by edge magnitude and edge direcion? Discuss some techniques for edge sharpening.	3	CO 2	
2.a)	Let f represents a M × N image. If the DFT and IDFT of f is given by P f Q and $P^{-1}f Q^{-1}$ respectively, then give expression for all transformation matrices.	3	CO 1	
2. b)	Let f (x, y) be a continous image function. The image is sampled at points x = jΔx, y = kΔy, for j = 1, ..., M and k = 1, ..., N. Where Δx and Δy are sampling intervals. Find expression for the sampled image fs (x, y). Also represent the sampled image in the frequency domain. (Hint: Assume ideal sampling using shifted dirac functions δ.)	4	CO 2	
3.a)	Explain the significance of Weiner filter in image restoration. Obtain expression for Wiener filter transfer function.	4	CO 2	
3.b)	List the steps involved in image restoration using Weiner filter. With a neat block schematic explain the digital implementation of Wiener filter.	3	CO 1	
4. a)	For the number plate identification of vehicles, the pre-processing step uses segmentation. Explain a suitable technique for this. Illustrate how do you arrive on thresholds ?	4	CO 3	
4.b)	Explain region merging technique. Discuss the criterion for merging two different regions in an image.	3	CO 1	
5.a)	Discuss the principles of fixed length and variable length encoding techniques. The word MISSISSIPPI RIVER is to be encoded using Huffman coding technique. Draw the Huffman tree and determine the Huffman code for the same.	4	CO 3	
5.b)	Compare and contrast lossy and loss-less compression techniques. Discuss entropy based compression techniques. Also explain fundamental properties of information.	3	CO 5	
6.a)	What is homography estimation? Explain the significance of homography matrix.	3	CO 5	
6.b)	Illustrate how RANSAC helps in estimating a mathematical model from a data set that contains outliers.	4	CO 2	
7.a)	Explain how to segment the foreground objects from the background of a sequence ? Discuss the principles of background subtraction.	3	CO 2	
7.b)	What do you mean by motion estimation? How do we estimate parameters?	4	CO 1	

Syllabus

Module - 1 (Image Representation) :

Image Representation: Gray scale and colour images, image sampling and quantization. Two dimensional orthogonal transforms: DFT, WHT, Haar transform, KLT, DCT. Image representation using SIFT, GIST and HOG features. Image enhancement - Filters in spatial and frequency domains, histogram- based processing, homomorphic filtering.

Module -2 (Image Resoration and Segmentaton)

Image Restoration: Degradation models, PSF, circulant and block-circulant matrices, deconvolution, restoration using inverse filtering, Wiener filtering and maximum entropy-based methods. Image segmentation: pixel classification, bi-level thresholding, multi- level thresholding. Edge detection, edge sharpening, edge profiles, edge operators, LoG, DoG. Hough transform.

Module 3 (Image Compression and Video Processing)

Fundamental Concepts of Image Compression: Compression models - Information theoretic perspective - Fundamental coding theorem-Lossless compression: Huffman Coding- arithmetic coding – bit plane coding - run length coding - Lossy compression: Transform
coding - Image compression standards. Video processing: Representation of digital video, Spatio-temporal sampling; Motion estimation; video filtering; Video compression, video coding standards.

Module -4 (Depth estimation and Multi-camera views)

Depth estimation and Multi-camera views: Perspective, binocular stereopsis: Camera and epipolar geometry; homography, rectification, DLT, RANSAC, 3-D reconstruction framework; auto-calibration.

Module -5 (Motion Analysis)

Motion Analysis: Background subtraction and modeling, Optical flow, KLT, spatio-temporal analysis, dynamic stereo; motion parameter estimation. Light at surfaces- Phong Model, shape from texture, color, motion and edges.

Text Book

1. Fundamentals of Digital Image Processing, A. K. Jain, Prentice Hall of India, 1989.

2. Digital Image Processing , R. C. Gonzalez, R. E. Woods, Digital Image Processing, Pearson Education, 2nd Edition, 2002.

3. Computer Vision algorithms and Applications, Richard Szeliski, Springer, New York, 2nd Edition, 2022.

Reference Books

1. Digital Image Processing, 4th Edition, Wiley Interscience, W. K. Pratt, Prentice Hall,2007.

2. Digital Image Processing, A. Rosenfold and A. C. Kak, Vols. 1 and 2, Prentice Hall, 2014.

3. Digital Image Restoration, H. C. Andrew and B. R. Hunt, Prentice Hall, 1977

4. Machine Vision, R. Jain, R. Kasturi and B.G. Schunck, McGraw-Hill International Edition, 1995

5. Digital Video Processing,A. M. Tekalp, Digital Video Processing , Prentice-Hall, 1995

6. Handbook of Image & Video Processing, A. Bovik, Academic Press, 2000.

7. Dictionary of Computer Vision and Image Processing, Second Edition, R. B. Fisher, T. P. Breckon, K. Dawson-Howe et al., ISBN:9781119941866, John Wiley & Sons Ltd., 2016

Course Plan

No	Topic	No. of Lectures [40Hrs]
1	**Image Representation**	
1.1	Image Representation: Gray scale and colour Images, image sampling and quantization.	2
1.2	Two dimensional orthogonal transforms: DFT, WHT, Haar transform, KLT, DCT.	2
1.3	Image representation using SIFT, GIST and HOG features.	2
1.4	Image enhancement - filters in spatial and frequency domains, histogram- based processing, homomorphic filtering.	3
2	**Image Resoration and Segmentaton**	
2.1	Image Restoration: Degradation Models, PSF, circulant and block-circulant matrices, deconvolution, restoration using inverse filtering.	2
2.2	Wiener filtering and maximum entropy-based methods.	2
2.3	Image Segmentation: Pixel classification, Bi-level thresholding, Multi- level thresholding.	3
2.4	Edge detection, edge sharpening, edge profiles, edge operators, LoG, DoG. Hough transform.	2
3	**Image Compression and video Processing**	
3.1	Fundamental Concepts of Image Compression: Compression models- Information theoretic perspective - Fundamental coding theorem.	2
3.2	Lossless Compression: Huffman Coding- Arithmetic coding – Bit plane coding - Run length coding.	
3.3	Lossy compression: Transform coding - Image compression	3

	standards.	
3.4	Video Processing: Representation of Digital Video, Spatio-temporal sampling; Motion Estimation; Video Filtering; Video Compression, Video coding standards.	3
4	**Depth estimation and Multi-camera views**	
4.1	Depth estimation and Multi-camera views: Perspective, Binocular Stereopsis.	2
4.2	Camera and Epipolar Geometry; Homography, Rectification.	
4.3	DLT, RANSAC, 3-D reconstruction framework.	3
4.4	Auto-calibration.	2
5	**Motion Analysis**	
5.1	Motion Analysis: Background Subtraction and Modeling.	2
5.2	Optical Flow, KLT, Spatio-Temporal Analysis, Dynamic Stereo.	2
5.3	Motion parameter estimation.	1
5.4	Light at Surfaces: Phong Model, Shape from Texture, color, motion and edges.	2

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
222EEC014	ARRAY SIGNAL PROCESSING	PROGRAM ELECTIVE 3	3	0	0	3

Preamble: This course aims to introduce the concept of sensor arrays and spatial signals to perform beam-forming in the context of direction of arrival estimation in noisy and interference environments.

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

CO 1	Understand the concept of spatial signals and spatial frequency.
CO 2	Understand the concept of sensor arrays and beam-forming.
CO 3	Understand the different methods of direction of arrival estimation.
CO 4	Understand the impact of noise and interference in DoA estimation.
CO 5	Understand the concept of spatial smoothing.

Mapping of course outcomes with program outcomes

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

Assessment Pattern

Bloom's Category	End Semester Examination
Apply	30
Analyse	20
Evaluate	10
Create	

Mark distribution

Total Marks	CIE	ESE	ESE Duration
100	40	60	2.5 hours

Continuous Internal Evaluation Pattern:

Preparing a review article based on peer reviewed Original publications (minimum10 Publications shall be referred):**15 marks**

Course based task/Seminar/Data Collection and interpretation: **15 marks**

Test paper (Shall include minimum of 80% of the syllabus)1 no.: **10 marks**

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 (such questions shall be useful in the testing of knowledge, skills, comprehension, application, analysis, synthesis, evaluation and understanding of the students). 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.

Syllabus

Signals in space and time : Spatial and Temporal Characteristics, Spatial Frequency, Noise and Interferences, Wave fields.

Spatial Frequency: Spatial Frequency Transform, Spatial Spectrum, Spatial Filtering, Beam-forming, Spatially white signal, Spatial sampling, Nyquist criterion. Aliasing.

Arrays and Spatial Filter : Sensor arrays - linear arrays, planar and random arrays, Uniform linear and weighted array, Delay Sum Beam-former, Beam Pattern Parameters, Array Steering, Null Steering, Array Performance Measures.

Optimum Waveform Estimation : Optimum Beam-formers – MVDR, MPDR, MMSE Beam-formers, Maximum SNR Beam-former, Discrete Interference.

Direction of Arrival Estimation : Parameter Estimation-Maximum Likelihood (ML) Estimation, Cramer-Rao Bounds. Non-parametric methods (Subspace Methods) – ESPRIT, MUSIC, Root MUSIC, Min-Norm Techniques. Spatial Smoothing.

Course Plan

No	Topic	No. of Lectures
1	**Signals in space and time**	
1.1	Spatial and Temporal Characteristics	2
1.2	Spatial Frequency or Wavenumber, Noise and Interferences	2
1.3	Wave fields - Far field and Near field signals	2
2	**Spatial Frequency**	
2.1	Spatial Frequency Transform, Spatial Spectrum.	2
2.2	Spatial Domain Filtering, Beam-forming, Spatially white signal	3
2.3	Spatial sampling, Nyquist criterion. Aliasing in spatial frequency domain	3
3	**Arrays and Spatial Filter**	
3.1	Sensor arrays - linear arrays, planar and random arrays.	2
3.2	Uniform linear array, Uniformly weighted linear array, Delay Sum Beam-former, Beam Pattern Parameters.	4
3.3	Array Steering, Null Steering. Array Performance Measures – Directivity, Array gain vs. Spatially white Noise.	3
4	**Optimum Waveform Estimation**	
4.1	Optimum Beam-formers – MVDR or Capon Beam-former, MPDR Beam-former.	3
4.2	MMSE Beam-former, Maximum SNR Beam-former	3
4.3	Discrete Interference-Plane wave interfering Signal	2
5	**Direction of Arrival Estimation**	
5.1	Parameter Estimation-Maximum Likelihood (ML) Estimation, Cramer-Rao Bounds.	3
95.2	Non-parametric methods (Subspace Methods) – ESPRIT, MUSIC, Root MUSIC, Min--Norm Techniques.	4
5.3	Spatial Smoothing – Forward Smoothing and Backward Smoothing	2

Text Book

1. 1. Harry L. Van Trees, “Optimum Array Processing- Part IV of Detection, Estimation, and Modulation Theory”, Wiley.

Reference Books

2. Dan E. Dugeon and Don H. Johnson. (1993). Array Signal Processing: Concepts and Techniques. Prentice Hall.
3. Petre Stoica and Randolph L. Moses. (2005, 1997) Spectral Analysis of Signals. Prentice Hall.

Model Question Paper

QP CODE
Reg.No:----------
Name----------

M.TECH DEGREE EXAMINATION

Discipline: Electronics and Communication Engg.

ARRAY SIGNAL PROCESSING

Time : 2.5 Hours Maximum: 60 Marks

PART-A

Answer all questions. Each question Carries 5 Marks.

1. Differentiate far field and near field signals.
2. Let the 3-Dimensional space be sampled by three vectors given by $X = [1\ 1\ 0]^T$, $Y = [0\ \ 2\ \ 1]^T$ and $Z = [0\ \ 0\ \ ½\ ]^T$. Obtain the periodicity of the sampling grid.
3. 'Array configuration is an issue in array signal processing'. Comment on this statement.
4. Evaluate how to estimate the signal waveform in the presence of noise using CAPON Beamformer.
5. 'MUSIC is a search procedure whereas ESPRIT is an eigen decomposition procedure'. Substantiate this statement with proper mathematical expressions.

(5 x 5 = 25 marks)

PART-B

Answer any 5 questions. Each question carries 7 Marks.

1. What is an interference signal? Bring out its impact in array signal processing.
2. What is a Vandermonde matrix? Illustrate its importance in direction of arrival estimation techniques.
3. Figure out the impact of array steering on the following beam pattern parameters?
   i) Shape of the beam pattern ii) Position of Nulls
   iii) Half Power Beam Width (HPBW) iv) Side lobe position
4. Consider a ULA with single source from a direction θ_1.Obtain the signal and noise subspaces using the correlation of the array output. Assume the signal power is σ_s^2 and the spatially white noise power to be σ_n^2.
5. Derive the expressions of Forward and Backward Covariance Smoothing Vectors for a ULA with N Sensors by dividing the total array.

6. Consider the modification to the MVDR Beamformer criterion. Let there be no distortion for $k = k_S$ and let there be a null at $k = k_I$. Let $Sn = \sigma^2 I$. Obtain the Beamformer.
7. Consider two ULAs of 8 sensors with spacing d. The two Beamforming vectors for the ULAs are given below.

   $W_1^H = [\ ½\ \ ½\ \ 1\ \ 1\ \ 1\ \ 1\ \ ½\ \ ½\ ]$ and

   $W_2^H = [\ 1\ \ 1\ \ ½\ \ ½\ \ ½\ \ ½\ \ 1\ \ 1\ ]$

Obtain the expression for the two Beam Patterns and the SNR array gain for each one.

(5 x 7 = 35 marks)

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
222EEC015	EMBEDDED NETWORKS	PROGRAM ELECTIVE 3	3	0	0	3

Preamble: This course focuses into the aspects of networking and then to the wireless concept. The aim of this course is to teach the student to understand about different embedded communication protocols, CAN and USB bus, embedded ethernet and wireless embedded networking and their applications.

Course prerequisites: NIL

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

CO 1	Understand the Serial and Parallel Communication Protocol in Embedded networking
CO 2	Apply USB in serial communication applications.
CO 3	Apply CAN protocols in network applications.
CO 4	Build an internet network using ethernet protocol.
CO 5	Implement Wireless sensor networks.

Mapping of course outcomes with program outcomes

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

Assessment Pattern

Bloom's Category	End Semester Examination (%)
Apply	40%
Analyse	20%
Evaluate	20%
Create	20%

Mark distribution

Total Marks	CIE	ESE	ESE Duration
100	40	60	2.5 hours

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

Continuous Internal Evaluation Pattern:

Continuous Internal Evaluation: 40 marks

Preparing a review article based on peer reviewed original publications (minimum 10 publications shall be referred)	15 marks
Course based task/Seminar/Data collection and interpretation	15 marks
Test paper, 1 no. (Test paper shall include minimum 80% of the syllabus.)	10 marks
TOTAL	**40 marks**

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 (such questions shall be useful in the testing of knowledge, skills, comprehension, application, analysis, synthesis, evaluation and understanding of the students). 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.
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 %.

Model Question paper

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

SECOND SEMESTER M. TECH DEGREE EXAMINATION

Program: M.Tech. in EC3 (Signal Processing, Signal Processing &Embedded Systems, Communication Engineering & Signal Processing)

Course Code: 222EEC015

Course Name: EMBEDDED NETWORKS

Max. Marks: 60 Duration: 150 Minutes

Part A

Answer All Questions. Each Carries 5 mark.

1. Justify the need for RS-485 standard.
2. With a neat diagram discuss USB interfacing with microcontroller.
3. Calculate the timing parameters of CAN Bus with Oscillator clock rate is 20 MHz and CAN bit rate is 125 KHz.
4. Discuss Internet Protocol addressing & routing
5. Explain the concept of robust routing in detail.

Part B

Answer any five questions: Each question carries 7 marks.

6. Illustrate the asynchronous serial input communications from serial devices.
7. Demonstrate about how serial data communication is preferred in I2C bus.
8. Implement an Universal Serial Bus (USB) based atmospheric pressure display on personal computer.
9. Elaborate the architecture of CAN with necessary sketches
10. Why Ethernet is popular for networks of embedded systems. Justify the statement, “Ethernet doesn’t guarantee real time transfers”.
11. Explain Sensor MAC protocol
12. Summarize the concept of data centric routing

SYLLABUS

Module 1 (10 hours)

Embedded communication protocols: Embedded Networking, Introduction, Serial/Parallel Communication – PC Parallel port programming: ISA/PCI Bus protocols
Serial communication protocols: RS232 standard, RS485 standard, Synchronous Serial Protocols - Serial Peripheral Interface (SPI), Inter Integrated Circuits (I2C), Firewire.

Module 2 (6 hours)

USB bus: Introduction, USB bus, Speed Identification on the bus – USB States.
USB bus communication: Packets –Data flow types –Enumeration –Descriptors

Module 3 (8 hours)

CAN Bus: Introduction, Frames –Bit stuffing –Types of errors – Nominal Bit Timing – PIC microcontroller CAN Interface –A simple application with CAN.

Module 4 (8 hours)

Ethernet: Elements of a network – Inside Ethernet – Building a Network: Hardware options – Cables, Connections and network speed.
Design choices: Selecting components –Ethernet Controllers – Using the internet in local and internet communications – Inside the Internet protocol.

Module 5 (8 hours)

Wireless embedded networking: Wireless sensor networks, Introduction – Applications – Network Topology – Localization – Time Synchronization - Energy efficient MAC protocols –SMAC – Energy efficient and robust routing – Data Centric routing.

Course Plan

Sl. No	Topic	No. of Lectures
1	**Embedded communication protocols**	
1.1	Introduction, Embedded Networking	2
1.2	Serial/Parallel Communication – PC Parallel port programming - ISA/PCI Bus	2
1.3	Serial communication protocols – RS232 standard – RS485 standard – Synchronous Serial Protocols	3
1.4	Serial Peripheral Interface (SPI), Inter Integrated Circuits (I2C) protocols, Firewire	3
2	**USB Bus**	
2.1	USB bus, Introduction, USB bus, Speed Identification on the bus – USB States	3
2.2	USB bus communication: Packets Data flow types – Enumeration –Descriptors	3
3	**CAN Bus**	
3.1	Introduction, Frames –Bit stuffing	2
3.2	Types of errors – Nominal Bit Timing	2
3.3	PIC microcontroller CAN Interface	2
3.4	A simple application with CAN.	2
4	**Embedded Ethernet**	
4.1	Elements of a network – Inside Ethernet	1
4.2	Building a Network: Hardware options – Cables, Connections and network speed	2
4.3	Design choices: Selecting components –Ethernet Controllers Using the internet in local and internet communications – Inside the Internet protocol	5
5	**Wireless Embedded Networking**	
5.1	Wireless sensor networks, Introduction – Applications	2
5.2	Network Topology – Localization – Time Synchronization	3
5.3	Energy efficient MAC protocols –SMAC – Energy efficient and robust routing – Data Centric routing	3

Text Books

1. Frank Vahid, Tony Givargis"Embedded Systems Design: A Unified Hardware/Software Introduction", John & Wiley Publications, 2002.
2. Jan Axelson, "USB Complete The Developer's Guide" Fifth Edition, Lakeview Research.
3. BhaskarKrishnamachari, "Networking Wireless Sensors", Cambridge press 2005.
4. Marco Di Natalem, Haibo Zeng, Paolo Giusto, ArkadebGhosal, "Understanding and Using the Controller Area Network Communication Protocol - Theory and Practice", Springer 2012

Reference Books

1. Dogan Ibrahim, "Advanced PIC microcontroller projects in C", Elsevier 2008.
2. Jan Axelson,"Embedded Ethernet and Internet Complete", Penram publications, 2003.
3. Glaf P.Feiffer, Andrew Ayre and Christian Keyold, "Embedded Networking with CAN and CAN open", Embedded System Academy 2005.
4. Don Anderson, "USB System Architecture", Mindshare, Inc.
5. Jan Axelson, "Parallel Port Complete: Programming, interfacing and using the PC"s parallel printer port", Penram publications, 1996.

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
222EEC016	SIGNAL COMPRESSION TECHNIQUES	PROGRAM ELECTIVE 3	3	0	0	3

Preamble: This course gives a comprehensive knowledge of the essentials of Signal Compression Techniques.

Pre-requisites: Nil

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

CO 1	Differentiate between lossless and lossy compression/ coding techniques.
CO 2	Explain the concept of rate distortion theory and quantization theory.
CO 3	Understand different types of transforms
CO 4	Distinguish between different data compression standards
CO 5	Understand various audio compression techniques, Video compression Techniques and standards

Mapping of course outcomes with program outcomes

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

Assessment Pattern

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

Mark distribution

Total Marks	CIE	ESE	ESE Duration
100	40	60	2.5 hours

Continuous Internal Evaluation Pattern: Elective courses

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

Continuous Internal Evaluation:	**40 marks**
Preparing a review article based on peer reviewed Original publications (minimum 10 Publications shall be referred):	
Course based task/Seminar/Data	**15 marks**
Collection and interpretation:	**15 marks**
Test paper, 1 no.: Test paper shall include minimum 80% of the syllabus	**10 marks**

End Semester Examination Pattern: End Semester Examination: 60 marks

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 (such questions shall be useful in the testing of knowledge, skills, comprehension, application, analysis, synthesis, evaluation and understanding of the students). 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.

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 %.

Model Question Paper

Slot **[SLOT]**

Reg. No: Name:

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY
SECOND SEMESTER M.TECH DEGREE EXAMINATION

222EEC016 SIGNAL COMPRESSION TECHNIQUES

Time : 2.5 Hours Maximum : 60 Marks

PART A (Answer all questions)

Module I

1		Examine the necessary conditions for an optimal variable-length binary code.	5 marks

Module II

2		Define rate distortion function. List its properties. What is the rate distortion theorem?	5 marks

Module III

3		Explain Sub-band coding and briefly analyze its relevance in high quality audio compression.	5 marks

Module IV

4		Distinguish between Gzip and JBIG.	5 marks

Module V

5		Analyse the features of the MPEG video compression standard.	5 marks

PART B (Answer any one question from each module)

Module I

6	a	Encode and correctly decode the given sequence using the Burrows Wheeler Transform algorithm. Sequence: this~~b~~is~~b~~the	7 marks

OR

7	a	Detail the steps of Adaptive Huffman coding.	7 marks

Module II

8	a	Distinguish between the two types of Uniform quantizers. Give the expressions for SNR in dB	7 marks

OR

9	a	Explain the Vector Quantisation procedure, with appropriate schematics.	7 marks

Module III

10	a	Why is the Walsh Hadamard transform used for compression? Find the Hadamard transform of a one-dimensional image represented by F(x) = {1, 2, 0, 3}.	7 marks

Module IV

11	a	What is the Dolby AC3 standard? Give the block schematic of its algorithm.	7 marks

Module V

12	a	Explain the working and applications of the H.264 standard.	7 marks

Syllabus:

Compression Techniques; Huffman Coding; Arithmetic coding, Run Length Coding, Dictionary Techniques; Rate distortion theory; Quantization; vector quantization. Transforms for Compression, Coding. Data Compression standards; Speech Compression Standards; Audio Compression standards; Image Compression standards; Video Compression Standards

Course Plan

No.	Topic	No. of Lectures
1.	**Compression Techniques**	**8**
1.1	Lossless and Lossy Compression	1
1.2	Huffman Coding - Optimality of Huffman codes	1
1.3	Extended Huffman coding	1
1.4	Adaptive Huffman coding	1
1.5	Arithmetic coding	1

1.6	Run Length coding,	1
1.7	Lempel-Ziv coding,	1
1.8	Burrows Wheeler Transform.	1
2.	**Rate distortion theory, quantization techniques**	**8**
2.1	Rate distortion function R(D)	1
2.2	Properties of R(D)	1
2.3	Calculation of R(D) for the binary source	1
2.4	Rate distortion theorem - Converse of the Rate distortion theorem	1
2.5	Quantization – Uniform & Non-uniform	1
2.6	Optimal and adaptive quantization	1
2.7	Vector quantization,	1
2.8	Optimality conditions for VQ	1
3	**Transforms for Compression, Coding**	**8**
3.1	Mathematical Preliminaries for Transforms,	1
3.2	Karhunen Loeve Transform	1
3.3	Discrete Cosine and Sine Transforms	1
3.4	Discrete Walsh Transform Discrete Hadamard Transform	1
3.5	Discrete Walsh Hadamard Transform	1
3.6	Wavelet Based Compression	1
3.7	Transform coding	1
3.8	Subband coding	1
4.	**Data Compression and Image compression standards**	**8**
4.1	Zip and Gzip	1
4.2	PCM, G.711, G.729	1
4.3	ADPCM G.726	1
4.4	SBC CODEC	1
4.5	LD-CELP	1
4.6	G.722	1
4.7	G.723.1	1
4.8	JPEG 2000 standards, JBIG	1
5.	**Audio compression techniques, Video compression Techniques, Standards**	**8**
5.1	Need for audio compression	1
5.2	MPEG audio encoding	1
5.3	MPEG audio decoding	1
5.4	AC standard	1
5.5	Dolby AC3	1
5.6	Need for video compression, Motion Compensation	1
5.7	H.261	1
5.8	H.264	1

Text books

1. Khalid Sayood, “Introduction to Data Compression”, Morgan Kaufmann Publishers.,
   Second Edn, 2005.
2. David Salomon, “Data Compression: The Complete Reference”, Springer Publications, 4th Edn., 2006.
3. Thomas M. Cover, Joy A. Thomas, “Elements of Information Theory," John Wiley &
   Sons, Inc., 1991.

Reference books

1. Toby Berger, “Rate Distortion Theory: A Mathematical Basis for Data Compression”, Prentice Hall, Inc., 1971.
2. K.R.Rao, P.C.Yip, “The Transform and Data Compression Handbook”, CRC Press.,
   2001.
3. R.G.Gallager, “Information Theory and Reliable Communication”, John Wiley & Sons, Inc., 1968.
4. Ali N. Akansu, Richard A. Haddad, “Multiresolution Signal Decomposition: Transforms, Subbands and Wavelets”, Academic Press., 1992
5. Martin Vetterli, Jelena Kovacevic, “Wavelets and Subband Coding”, Prentice Hall Inc., 1995.

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
222EEC017	FIBER OPTIC COMMUNICATION SYSTEMS	PROGRAM ELECTIVE 3	3	0	0	3

Preamble: Development of fiber optics together with microelectronics is a major breakthrough in information revolution. In fiber optic communication light is the carrier and the optical fiber is communication channel. This course analyses characteristics of different optical devices, optical fiber and optical networks.

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

CO 1	Analyse of different optical fiber parameters and nonlinear effects
CO 2	Evaluate variousOptical sources and modulators
CO 3	Evaluate the performance of different optical detectors.
CO 4	Design a Fibre Optic communication link.
CO 5	Analyse optical multiplexing and Optical Wireless Communication Channels
CO 6	Analyse Optical networks.

Mapping of course outcomes with program outcomes

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

Assessment Pattern

Bloom's Category	End Semester Examination
Apply	20 %
Analyse	50 %
Evaluate	30 %
Create	

Mark distribution

Total Marks	CIE	ESE	ESE Duration
100	40	60	2.5 hours

ELECTIVE COURSES

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

Continuous Internal Evaluation: 40 marks

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

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

Test paper, 1 no.: 10 marks

Test paper shall include minimum 80% of the syllabus.

End Semester Examination: 60 marks

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 (such questions shall be useful in the testing of knowledge, skills, comprehension, application, analysis, synthesis, evaluation and understanding of the students). 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.

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 %.

Model Question Paper

A P J ABDUL KALAM TECHNOLOGICAL UNIVERSITY
M.TECH DEGREE EXAMINATION

First Semester

Branch:

FIBER OPTIC COMMUNICATION SYSTEMS

Time: 2.5 Hours **Marks: 60**

Part A

Answer ALL Questions. Each question carries 5 marks

1. Classify optical fibers with their refractive index profile. (b)An optical signal at a specific wavelength has lost 50% of its power after traversing 3 Km of fiber. What is the attenuation in dB/km of this fiber.
2. Explain the photon generation technique in LED. A double hetrojunctionInGaAsP LED emitting at peak wavelength of 1310nm has radiative and non radiative recombination times of 30ns and 90ns respectively. If the drive current is 25mA find the internal quantum efficiency and internal power level.
3. Comment on SPM and XPM in, also the principle of solitons.
4. With a suitable figure describe Radio over Fibre system?
5. Explain the frame structure of SONET/SDH

Part B

Answer ANY FIVE Questions. Each question carries 7 marks

6. (a)Describe the mechanism of group velocity dispersion in optical fibers (4)

   (bExplain the principle and structure of photonic crystal fiber. (3)
7. Derive an expression for GVD in optical fibers. (7)
8. Explain the structure and working of VCSEL. (7)
9. Derive an expression for the Bit Error Rate in optical receivers. (7)
10. (a)Make the power budget and calculate the maximum transmission distance for a 1310nm light wave system operating at 100Mb=s and using an Laser for launching 1mW of average power into the fiber. Assume 0.2dB/km fiber loss, 0.2dB splice loss every 2 km, 1dB connector loss at each end of fiber link, and 100nW receiver sensitivity. Allow 6 dB system margin. (3)

    (b)Explain the working principle of EDFA with suitable diagram (4)
11. With suitable diagrams explain OFDM system. (7)

12. Explain Photonic Packet Switching and Optical Time Division Multiplexing (7)

Syllabus

Module I

Overview of Optical Communication System: Evolution of Fibre-Optic Communications, Light wave System Components, Optical Fibers-Types, Wave propagation, Fiber Modes, Dispersion in fibers, Fiber Losses, Nonlinear Effects, Plastic Optical Fibers, Photonic Crystal Fibers

Module II

Optical Transmitters and Receivers- LEDs and Semiconductor Lasers, Optical Signal Generation, MZM, Advanced Modulation Formats, Optical Receivers, Sources of Noise, SNR, Coherent Detection, Performance Evaluation (BER, Q, Receiver Sensitivity).

Module III

Lightwave System Design- Point to Point Links, Link Budget, Loss Management-Optical Amplifiers, OSNR,Dispersion Management-DCF, FBG,Dispersion-Equalizing Filters, Control of Nonlinear Effects-Solitons.

Module IV

Introduction to Multiplexing and Communication channels: WDM, DWDM, WDM Components, Subcarrier Multiplexing , Radio over Fiber, OFDM, Indoor Optical Wireless Communication Channels.

Module V

Optical Networks –SDH/SONET, Layers, Physical network topologies, Access Networks- Optical Transport Network , WDM Network Elements, Storage-area networks, Photonic Packet Switching, Optical Time Division Multiplexing and Synchronization

Course Plan

No	Topic	No. of Lectures
1	**Overview of Optical Communication System :**	
1.1	Evolution of Fibre-Optic Communications, Light wave System Components.	1
1.2	Optical Fibers-Types, Wave propagation, Fiber Modes, Dispersion in fibers, GVD, PMD , Fiber Losses	3
1.3	Nonlinear Effects- Self Phase Modulation Cross Phase Modulation, Four Wave Mixing, Stimulated Raman and Brillouin Scattering.	2
1.4	Fiber Design- Plastic Optical Fibers, Photonic Crystal Fibers	2

2	**Optical Transmitters and Receivers-**	
2.1	LEDs and Semiconductor Lasers- structure and characteristics, VCSEL	2
2.2	Optical Signal Generation-Direct Modulation, External Modulation, MZM, Advanced Modulation Formats	2
2.3	Optical Receivers- PIN and APD Detectors, Receiver design, Sources of Noise, SNR,	2
2.4	Coherent Detection , Homodyne and Heterodyne detection, SNR	2
2.5	Performance Evaluation of an OOK link- BER, Q, Receiver Sensitivity	2
3	**Lightwave System Design**	
3.1	Point-to-Point Links, Link Budget(Power & Rise time)	2
3.2	Loss Management-Compensation of Fiber Losses, Optical Amplifiers- EDFA and RAMAN Amplifiers, Optical Signal-To-Noise Ratio.	2
3.3	Dispersion Management-Dispersion-Compensating Fibers,Fiber Bragg Gratings, Dispersion-Equalizing Filters	3
3.4	Control of Nonlinear Effects-Solitons in Optical Fibers	1
4	**Introduction to Multiplexing and Communication channels**	
4.1	WDM Light wave Systems, Architecture,WDM Components, DWDM , Applications	4
4.2	Subcarrier Multiplexing-Analog and Digital SCM Systems, -Radio over Fibre Systems, OFDM.	3
4.3	Indoor Optical Wireless Communication Channels – Infrared Optical Wireless Communications, Visible Light Communications	2
5	**Optical Networks –**	
5.1	SDH/SONET Layers, Frame Structure, Physical Layer, topologies, Access Networks	3
5.2	Optical Transport Network, OTN hierarchy. Frame Structure, Multiplexing	3
5.3	WDM Network Elements, Optical Line terminals. Optical add/Drop multiplexers, Optical crossconnects	2
5.4	Storage-area networks, Photonic Packet Switching OpticalTimeDivisionMultiplexing and Synchronization	2

Reference Books

1. Fiber Optic Communication- GP Agrawal(Wiley 4th ed)
2. Rajiv Ramaswami and Kumar N Sivarajan- Optical networks, A practical perspective (Morgan kaufmann , 2nd 2001)
3. R.G.Hunsperger , Integrated optics Theory and technology (Springer series in Optical Sciences “, 5th edition 2002)
4. Advanced Optical and Wireless Communications Systems, IvanB.Djordjevic (Springer)
5. G.G Keiser , Optical Fiber Communication (TMH,4th Ed)
6. John M.Senior ,OpticalFiber Communications Principles and practice PHI,1992 .

SEMESTER II

PROGRAM ELECTIVE IV

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
222EEC018	WIRELESS AND MOBILE COMMUNICATION	PROGRAM ELECTIVE 4	3	0	0	3

Preamble: This course introduces the important aspects in Wireless & Mobile Communication. The evolution of different generations of mobile systems, access and diversity techniques are dealt in the course. The course gives an overview from RF channel modelling to next generation networks.

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

CO 1	Analyse the characteristics of wireless channels.
CO 2	Apply the diversity concepts for wireless communication.
CO 3	Evaluate different multiple access techniques.
CO 4	Evaluate the challenges in mobile communication systems.
CO 5	Analyse the new trends in wireless & mobile communications networks.

Mapping of course outcomes with program outcomes

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

Assessment Pattern

Bloom's Category	End Semester Examination
Apply	30
Analyse	30
Evaluate	30
Create	10

Mark distribution

Total Marks	CIE	ESE	ESE Duration
100	40	60	2.5 hours

Continuous Internal Evaluation Pattern:

Evaluation Method	**Marks**
Preparing a review article based on peer reviewed Original publications (minimum 10 Publications shall be referred)	15
Course based task/ Seminar/ Data Collection and interpretation	15
Test paper, 1 no. (Test paper shall include minimum 80% of the syllabus.)	10
Total	40

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
Answer all questions. Each question carries 5 marks.
This section will have 5 numerical/ short answer questions with 1 question from each module.

Part B
Answer any five. Each question carries 7 marks.
This section will have 7 long answer questions, with minimum one question from each module.

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 %.

Model Question Paper

Slot [E]

Reg. No: Name:

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

SECOND SEMESTER M.TECH DEGREE EXAMINATION

Subject: 222EEC018 Wireless and Mobile Communication

Time : 2.5 Hours Maximum : 60 Marks

PART A (Answer all questions)

		Module I	Marks
1		Analyse the factors affecting path loss in wireless communication.	5
		Module II	
2		Evaluate the different diversity technique used in wireless receivers.	5
		Module III	
3		With the help of a block schematic, analyse the working of a PN sequence generator.	5
		Module IV	
4		Analyse the advantages and disadvantages of 2G and 3G systems.	5
		Module V	
5		Analyse how Quality of Service is achieved in 5G communication.	5

PART B (Answer any Five question)

6	a	Define the terms coherence bandwidth, Doppler spread and coherence time.	3
	b	Differentiate between fast fading and slow fading of channels.	4
7	a	Analyse the working of different transmit diversity schemes.	3
	b	Draw the relevant block schematics and evaluate the array gains of Maximal Ratio Combining (MRC) and Equal Gain (EG) combining methods.	4
8		Prove that a Multiple Input Multiple output (MIMO) system can be represented by a set of parallel channels.	7
9		Prove that a DSSS - CDMA system is capable of both jamming rejection and multipath rejection.	7

10	a	Give the expression for calculating PAPR and explain its significance.	3
	b	Describe a method to create a multicarrier signals from discrete inputs.	4
11	a	Analyse the different handover procedures in cellular communication.	3
	b	Evaluate different methods for improving coverage & capacity in a cellular systems.	4
12		Enumerate the key enablers and Key Performance Indicators of a 6G network.	7

Syllabus

Module 1:Channel Models: (8)

Shannon's capacity, bandwidth and power-limited regimes. Free space propagation model, factors affecting path loss. Parameters of mobile multipath channels-time dispersion parameters, coherence bandwidth, Doppler spread and coherence time. Types of small-scale fading-fading effects due to multipath time delay spread, flat fading, frequency selective fading, fading effects due to Doppler spread-fast fading, slow fading. Narrow band and wideband fading models. Physical modeling of wireless channels - time and frequency coherence - statistical channel models - power delay profile.

Module 2:Diversity Techniques: (8)

Independent fading paths - receiver diversity - selection combing -threshold combing - maximal-ratio combing - equal gain combing - transmitter diversity - channel known at transmitter - channel unknown at transmitter - Rake receiver - The Alamouti scheme-transmit & receive diversity-MIMO systems. MIMO applications in wireless system - MIMO-OFDM.

Module 3:Multi - Access Methods: (8)

TDMA/FDMA: A case study of GSM. CDMA: Direct sequence spread spectrum - Frequency hopping systems-Anti-jamming - Pseudo Random (PN) sequence - Maximal length sequences - Gold sequences - Generation of PN sequences. Power control in CDMA. Data transmission using multiple carriers - Discrete implementation of multicarrier modulation - OFDM - Advantages Mitigation of subcarrier fading - Timing and frequency offset in OFDM- PAPR reduction of OFDM signals.

Module 4:Cellular Communication: (8)

Overview of cellular systems and evolution 1G to 3G. Cellular concepts - Frequency reuse, Co-channel and Adjacent channel Interference. Improving coverage & capacity in Cellular Systems - Cell splitting, Sectoring. Hand over - Hard and soft hand off strategies. Fundamentals of 4G - Advantages and Applications of 4G - Architecture and representative protocols.

Module 5: Emerging Connectivity: (8)

Introduction to 5G - Architecture - Quality of Service - Radio Network - requirements, Security - Specifications – Standardization. B5G- Introduction to 6G- requirements - spectrum- key enablers- Key Performance Indicators - Introduction to Vehicle-to-Vehicle communications.

Course Plan

No	Topic	No. of Lectures
1	**Channel Models**	**(8)**
1.1	Shannon's capacity - bandwidth and power-limited regimes.	1
1.2	Free space propagation model - factors affecting path loss.	1
1.3	Parameters of mobile multipath channels-time dispersion parameters, coherence bandwidth- Doppler spread and coherence time.	1
1.4	Types of small-scale fading-fading effects due to multipath time delay spread - flat fading- frequency selective fading,	1
1.5	Fading effects due to Doppler spread-fast fading slow fading.	1
1.6	Narrow band and wideband fading models.	1
1.7	Physical modelling of wireless channels - time and frequency coherence	1
1.8	Statistical channel models - power delay profile.	1
2	**Diversity Techniques**	**(8)**
2.1	Independent fading paths - receiver diversity - selection combing -threshold combing - maximal-ratio combing - equal gain combing	2
2.2	Transmitter diversity - channel known at transmitter - channel unknown at transmitter - Rake receiver	2
2.3	The Alamouti scheme-transmit & receive diversity-MIMO systems.	2
2.4	MIMO applications in wireless system - MIMO-OFDM.	2
3	**Multi - Access Methods**	**(8)**
3.1	TDMA/FDMA: A case study of GSM. CDMA: Direct sequence spread spectrum - Frequency hopping systems.	2
3.2	Anti-jamming - Pseudo Random (PN) sequence - Maximal length sequences - Gold sequences - Generation of PN sequences. Power control in CDMA.	2
3.3	Data transmission using multiple carriers - Discrete implementation of multicarrier modulation - OFDM - Advantages	2
3.4	Mitigation of subcarrier fading - Timing and frequency offset in OFDM- PAPR reduction of OFDM signals.	2
4	**Cellular Communication**	**(8)**

4.1	Overview of cellular systems and evolution 1G to 3G. Cellular concepts	2
4.2	Frequency reuse, Co-channel and Adjacent channel Interference.	2
4.3	Improving coverage &capacity in Cellular Systems - Cell splitting, Sectoring. Hand over - Hard and soft hand off strategies.	2
4.4	Fundamentals of 4G - Advantages and Applications of 4G - Architecture and representative protocols.	2
5	**Emerging Connectivity**	**(8)**
5.1	Introduction to 5G - Architecture - Quality of Service - Radio Network requirements,	2
5.2	Security - Specifications – Standardization - B5G	2
5.3	Introduction to 6G- requirements - spectrum- key enablers- Key Performance Indicators	2
5.4	Introduction to Vehicle to-Vehicle communications.	2

Text Books

1. Andrea Goldsmith, Wireless Communications, Cambridge University press.
2. A.J.Viterbi, CDMA- Principles of Spread Spectrum, Addison Wesley.4.
3. Shinsuke Hara and Ramjee Prasad, Multicarrier Techniques for 4G MobileCommunications, Artech House.
4. AngelikiAlexiou, 5G Wireless Technologies, IET.

Reference Books

1. Simon Haykin and Michael Moher, Modern Wireless Communications, Pearson Education.
2. Jonathan Rodriguez, Fundamentals of 5G Mobile Networks, Wiley.
3. Paulo Sergio Rufino Henrique and Ramjee Prasad, 6G: The Road to the Future Wireless Technologies 2030, River Publishers.

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
222EEC019	BIOMEDICAL SIGNAL PROCESSING	PROGRAM ELECTIVE 4	3	0	0	3

Preamble: The course introduces the fundamental concepts, principles and application of biomedical signal processing and design. This course goes deeper into the various aspects of artifact removal in biosignals, cardio vascular applications, neurological applications and model based spectral analysis.

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

CO 1	Analyze biomedical signals properties and effects of noise in biomedical instruments
CO 2	Create a model of bio medical signal
CO 3	Analyse ECG signals for Cardio vascular applications
CO 4	Analyse EEG signals for Neurological applications
CO 5	Analyse model based spectral analysis

Mapping of course outcomes with program outcomes

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

Assessment Pattern

Bloom's Category	End Semester Examination
Apply	10
Analyse	30
Evaluate	10
Create	10

Mark distribution

Total Marks	CIE	ESE	ESE Duration
100	40	60	2.5 hours

Continuous Internal Evaluation Pattern:

Preparing a review article based on peer reviewed Original publications (minimum10 Publications shall be referred): **15 marks**

Course based task/Seminar/Data Collection and interpretation: **15 marks**

Test paper (Shall include minimum of 80% of the syllabus)1 no.: **10 marks**

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 (such questions shall be useful in the testing of knowledge, skills, comprehension, application, analysis, synthesis, evaluation and understanding of the students). 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.

Model Question Paper

Name:
Reg. No:

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

SECOND SEMESTER M.TECH DEGREE EXAMINATION

Subject: 222EEC019BIOMEDICAL SIGNAL PROCESSING

Time : 3 Hours Maximum : 60 Marks

PART A (Answer all questions)

1		Explain the structure of neuron with diagram.	5 marks
2		With diagram, explain the significance of ECG graph	5 marks
3		Explain artifacts in EEG.	5 marks
4		Discuss about various sleep disorders	5 marks
5		Describe the categorization of EEG activities.	5 marks

PART B (Answer any 5 questions)

6.	a	Describe the following biomedical signals: (i) Electroencephalogram (EEG) (ii) Electromyogram (EMG).	4 marks
	b	Briefly explain the resting and action potential.	3 marks
7.		How matched filters can be used in the waveform analysis of EEG?	7 marks
8.		Give details of any one EEG segmentation scheme which is based on nonparametric estimation of the signal statistics?	7 marks
9.		With the help of a neat block diagram, explain the Pan-Tompkins algorithm for QRS complex detection in an on-going ECG signal.	7 marks
10.		Discuss the following in ECG signal processing: baseline wandering, power line interference and high frequency EM noise.	7 marks
11.	a	Analyse the ECG parameters and their estimation.	4 marks
	b	Discuss the first and second heart sounds and murmurs of heart.	3 marks
12.		With the help of a neat diagram, explain the method of EEG measurement and describe the frequencies of interest.	7marks

Syllabus

MODULE I

Review of biomedical signal :
Tasks in Biomedical Signal Processing - Computer Aided Diagnosis. Origin of bio-potentials - Processing of Random & Stochastic signals - Introduction to Biomedical Signals - Examples of Biomedical signals - ECG, EEG, EMG etc-Fourier Transform and Time-Frequency Analysis - (Wavelet Transform) of biomedical signals- Properties and effects of noise in biomedical instruments - Filtering in biomedical instruments

MODULE II

Concurrent, coupled and correlated processes:
Concurrent, coupled and correlated processes - illustration with case studies
Adaptive and optimal filtering - Modelling of Biomedical signals- Detection of biomedical signals in noise - removal of artifacts of one signal embedded in another -Maternal-Fetal ECG – Muscle - contraction interference. Event detection - case studies with ECG & EEG

MODULE III

Cardio vascular applications :
Basic ECG - Electrical Activity of the heart- ECG data acquisition – ECG parameters & their estimation - Use of multi scale analysis for ECG parameters estimation- Noise & Artifacts - ECG Signal Processing: Baseline Wandering, Power line interference, Muscle noise filtering - QRS detection - Arrhythmia analysis

MODULE IV

Neurological Applications:
The electroencephalogram - EEG rhythms & waveform - categorization of EEG activity - recording techniques- EEG applications- Epilepsy, sleep disorders- Brain computer interface. Modelling EEG- linear, stochastic models - Non linear modelling of EEG- Artifacts in EEG & their characteristics and processing -

MODULE V

Model based spectral analysis:
EEG segmentation – Joint Time- Frequency analysis correlation analysis of EEG channels-coherence analysis of EEG channels- Independent component Analysis - Cocktail party problem applied to EEG signals

Course Plan

No	Topic	No. of Lectures
1	**Review of Biomedical Signal**	
1.1	Fourier Transform and Time Frequency Analysis - (Wavelet) of biomedical signals- Processing of Random & Stochastic signals -	2hrs
1.2	Introduction to Biomedical Signals - Examples of Biomedical signals - ECG, EEG, EMG etc	2hrs
1.3	Tasks in Biomedical Signal Processing - Computer Aided Diagnosis. Origin of bio-potentials	2hrs
1.4	Properties and effects of noise in biomedical instruments - Filtering in biomedical instruments	2hrs
2	**Concurrent, coupled and correlated processes**	
2.1	Concurrent, coupled and correlated processes - illustration with case studies	2hrs
2.2	Adaptive and optimal filtering	3hrs
2.3	Modelling of Biomedical signals - Detection of biomedical signals in noise - removal of artifacts of one signal embedded in another -Maternal-Fetal ECG – Muscle - contraction interference. Event detection - case studies with ECG & EEG	3hrs
3	**Cardio vascular applications :**	
3.1	Basic ECG - Electrical Activity of the heart	2hrs
3.2	ECG data acquisition – ECG parameters & their estimation - Use of multiscale analysis for ECG parameters estimation	2hrs
3.3	Noise & Artifacts - ECG Signal Processing: Baseline Wandering, Power line interference, Muscle noise filtering	2hrs
3.4	QRS detection - Arrhythmia analysis	2hrs
4	**Neurological Applications:**	
4.1	The electroencephalogram - EEG rhythms & waveform - categorization of EEG activity - recording techniques	2hrs
4.2	EEG applications- Epilepsy, sleep disorders	2hrs
4.3	Brain computer interface. Modelling EEG- linear, stochastic models - Non linear modelling of EEG	2hrs
4.4	Artifacts in EEG & their characteristics and processing - Model based spectral analysis	2hrs
5	**Model based spectral analysis**	
5.1	EEG segmentation	2hrs
5.2	Joint Time- Frequency analysis correlation analysis of EEG channels	2hrs
5.3	coherence analysis of EEG channels	2hrs
5.4	Independent component Analysis - Cocktail party problem applied to EEG signals	2hrs

Reference Books

1. Bruce, Eugene N. "Biomedical signal processing and signal modeling: Wiley series in telecommunications and signal processing." (2001).

2.Sörnmo, Leif, and Pablo Laguna. *Bioelectrical signal processing in cardiac and neurological applications*. Vol. 8. Academic press, 2005.

3.Rangayyan, “Biomedical Signal Analysis”, Wiley 2002.

4.D.C.Reddy , “ Biomedical Signal Processing: Principles and techniques”, Tata McGraw Hill, New Delhi, 2005.

5.Enderle, John, and Joseph Bronzino, eds. *Introduction to biomedical engineering*. Academic press, 2012.

6. Sanei, Saeid, and Jonathon A. Chambers. *EEG signal processing*. John Wiley & Sons, 2013.

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
222EEC020	AUDIO PROCESSING	PROGRAM ELECTIVE 4	3	0	0	3

Preamble: This course aims to develop in-depth understanding of fundamentals of hearing mechanism, cochlear signal processing, auditory filters, critical band structure, psychoacoustic analysis, spatial audio perception & rendering and audio compression algorithms, enabling them to apply that in the research and development of audio processing applications.

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

CO 1	Explain the hearing mechanism, cochlear signal processing, auditory filter banks, hearing aids and cochlear implants
CO 2	Apply the knowledge of critical band structure, masking phenomenon and psycho acoustic analysis in developing audio processing applications
CO 3	Explain the various audio compression methods and audio coding standards like MPEG2-AAC
CO 4	Apply the knowledge of spacial audio perception and room acoustics in the development of spatial audio systems
CO 5	Analyse the quality of audio signals using objective and subjective methods and explain audio processing techniques for music applications

Mapping of course outcomes with program outcomes

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

Assessment Pattern

Bloom's Category	End Semester Examination
Apply	40%
Analyse	40%
Evaluate	20%
Create	

Mark distribution

Total Marks	CIE	ESE	ESE Duration
100	40	60	2.5 hours

Continuous Internal Evaluation Pattern:
Preparing a review article based on peer reviewed Original publications (minimum10 Publications shall be referred):**15 marks**

Course based task/Seminar/Data Collection and interpretation: **15 marks**

Test paper (Shall include minimum of 80% of the syllabus)1 no.: **10 marks**

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 (such questions shall be useful in the testing of knowledge, skills, comprehension, application, analysis, synthesis, evaluation and understanding of the students). 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.

Model Question Paper
No. of Pages: 2 **D**

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

FIRST SEMESTER M.TECH DEGREE EXAMINATION

Branch: Electronics and Communication Engineering

Stream(s): Signal Processing

Course Code & Name: **2222EEC020** - **AUDIO PROCESSING**

Max. Marks: 60 Duration: 2.5 hours

PART A

Answer all questions. Each question carries 5 marks.

1. Distinguish between Mel frequency scale and Bark scale.
2. How is simultaneous masking made use of in audio applications?
3. How is perceptual irrelevancy removal used in speech compression?
4. How do you create mid and side channels in a Mid-Side stereo?

5. How is automatic Music Information Retrieval performed?

PART B

Answer any five questions. Each question carries 7 marks.

6. How does a hearing aid improve the hearing experience?
7. What do you mean by the term absolute threshold of hearing? Refer to Fig. 1. State which of the following frequencies a person will be able to hear. i) 63Hz of SPL 10dB, ii) 1.5KHz of SPL 10dB and iii) 14KHz of SPL 10dB.

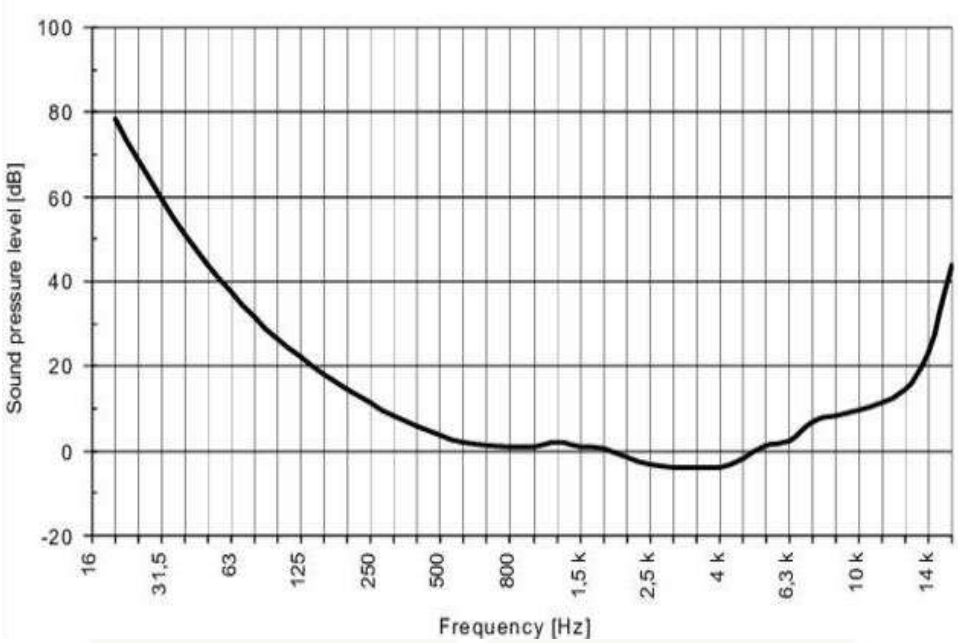


Fig.1

8. How can we suppress the effects of pre-echo?
9. How can we develop a lossless coding method for audio compression?
10. Explore the use of MDCT in audio coding.
11. How do we localize sound?
12. How can we analyse the quality of audio using an objective method?

Syllabus

MODULE I

Signal Processing Models of Audio Perception: Basic anatomy of hearing System-Outer ear, middle ear and inner ear, Cochlea and signal processing in cochlea, Auditory Filter Banks, Gamma-tone filters, Bark Scale, Mel frequency scale, Hearing aids, Cochlear implants,

MODULE II

Psycho-acoustic analysis: Absolute Threshold of Hearing, Critical Band Structure, Simultaneous Masking, Temporal Masking, MPEG psycho-acoustic model

MODULE III

Audio compression methods: Redundancy removal and perceptual irrelevancy removal, Sub-band coding, MDCT, Transform coding, Pre-echo and pre-echo suppression, MPEG2-AAC coding standard, Lossless coding methods

MODULE IV

Spatial Audio Perception and rendering: Sound localization and space perception, Head related transfer functions, Stereo and multi-channel audio, Mid-Side Stereo, Intensity Stereo, Binaural Cue Coding, Spatial audio standards, Room acoustics: Sound propagation in rooms, Modeling the influence of short and long term reverberation, Modeling room impulse responses and head related impulse responses.

MODULE V

Music Transcription: automatically deriving notes, beats, and chords from music signals, Music Information Retrieval: audio-based genre classification, artist/style identification, and similarity estimation, Objective analysis methods-PEAQ, Subjective analysis methods-MOS score, MUSHRA score

Course Plan

No	Topic	No. of Lectures
1	**MODULE I**	
1.1	Basic anatomy of hearing System-Outer ear, middle ear and inner ear, Cochlea and signal processing in cochlea	2
1.2	Auditory Filter Banks, Gamma-tone filters, Bark Scale, Mel frequency scale	2
1.3	Hearing aids, Cochlear implants	2
2	**MODULE II**	
2.1	Absolute Threshold of Hearing, Critical Band Structure	3
2.2	Simultaneous Masking, Temporal Masking	3
2.3	MPEG psycho-acoustic model	2
3	**MODULE III**	
3.1	Redundancy removal and perceptual irrelevancy removal,	3

	Sub-band coding	
3.2	MDCT, Transform coding, Pre-echo and pre-echo suppression	3
3.3	MPEG2-AAC coding standard, Lossless coding methods.	3
4	**MODULE IV**	
4.1	Sound localization and space perception, Head related transfer functions	3
4.2	Stereo and multi-channel audio, Mid- Side Stereo, Intensity Stereo, Binaural Cue Coding, Spatial audio standards	3
4.3	Room acoustics: Sound propagation in rooms, Modeling the influence of short and long term reverberation, Modeling room impulse responses and head related impulse responses.	3
5	**MODULE V**	
5.1	Music Transcription, automatically deriving notes, beats, and chords from music signals.	3
5.2	Music Information Retrieval, audio-based genre classification, artist/style identification, and similarity estimation.	3
5.3	Objective analysis methods- PEAQ, Subjective analysis methods - MOS score, MUSHRA score	2

Reference Books

1. Audio Signal Processing and Coding, Andreas Spanias, Ted Painter and VenkittaramAtti, Wiley-Inter Science publication, 2006
2. Speech and Audio Signal Processing: Processing and Perception of Speech and Music, 2nd Edition, Ben Gold, Nelson Morgan, Dan Ellis, ISBN: 978-0-470-19536-9
3. Spatial Audio (Music Technology Series), 1st Edition, Francis Rumsey, ISBN: 0240516230

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
222EEC021	DEEP LEARNING	PROGRAM ELECTIVE 4	3	0	0	3

Preamble: This course provides an introduction to key concept in deep learning and equip students with knowledge required to develop best deep learning solutions for real world problems in domains such as computer vision, natural language processing etc.

Course Outcomes: The COs shown are only indicative. For each course, there can be 4 to 6 COs.

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

CO 1	Demonstrate the uses and limitations of fully connected neural networks
CO 2	Compare different CNN networks for classification and detection in terms of architecture, performance and computational requirements
CO 3	Develop a convolutional neural network for a real-world application
CO 4	Apply regularization and optimization techniques in CNN training
CO 5	Demonstrate the use of RNNS and LSTM for analysing sequential data
CO 6	Apply the concepts of attention models, transformers and generative models

Mapping of course outcomes with program outcomes

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

Assessment Pattern

Bloom's Category	End Semester Examination
Apply	60%
Analyse	40%
Evaluate	
Create	

Mark distribution

Total Marks	CIE	ESE	ESE Duration
100	40	60	2.5 hours

Continuous Internal Evaluation Pattern:

Course project: 15 marks
Course based task/Seminar/Quiz: 15 marks
Test paper, 1 no.: 10 marks

End Semester Examination Pattern:

60 Marks
Part A: 5×5 Marks
Part B: 5×7 Marks

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Suppose you have a 3-dimensional input $x = (x_1, x_2, x_3) = (2, 2, 1)$ 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.
2. Consider the case of the XOR function in which points $\{(0,0),(1,1)\}$ belong to one class, and $\{(1,0),(0,1)\}$ belong to the other class. Design a multilayer perceptron for this binary classification problem.

Course Outcome 2 (CO2)

1. Implement AlexNet, VGG Net, ResNet and Inception Net for a classification problem. Compare and contrast the performance in terms of accuracy and computational requirements.
2. Implement RCNN, Fast RCNN, Faster RCNN, YOLO and Mask RCNN for detection problem. Compare and contrast the performance in terms of accuracy and computational requirements.

Course Outcome 3(CO3):

3. Draw and explain the architecture of convolutional neural networks.
4. You are given a classification problem to classify the handwritten digits. Suggest a learning algorithm with its architecture, an objective function, and an optimization routine, along with how input and output will be prepared for the classifier

Course Outcome 4 (CO4):

1. Explain how L2 regularization improves the performance of deep feed forward neural networks.
2. Explain the use of data augmentation and dropouts

Course Outcome 5 (CO5):

1. Illustrate the workings of the RNN with an example of a single sequence defined on a vocabulary of four words
2. Draw and explain the architecture of LSTM.
3. List the differences between LSTM and GRU

Course Outcome 6 (CO6):

1. Explain the use of transformers for image recognition
2. Explain the basic principle and architecture of generative adversarial network

Model Question paper

PART A

1 There is huge gap between training accuracy and testing accuracy, while training a particular machine learning model. What might be the reason. Suggest possible methods of overcoming it 5

2 Draw the block diagram of a naïve inception block. What is the disadvantage of this block? Explain how adding 1x1 convolution helps to overcome the difficulty. 5

3 Consider a Convolutional Neural Network having three different convolutional layers in its architecture as 5

Layer-1	Filter Size – 3×3, Number of Filters – 10, Stride – 1, Padding – 0
Layer-2	Filter Size – 5×5, Number of Filters – 20, Stride – 2, Padding – 0
Layer-3	Filter Size – 5×5 , Number of Filters – 40, Stride – 2, Padding – 0

If we give a 51×51 RGB image as input to the network, then determine the dimension of the vector after passing through layer 3 in the architecture.

4 You have a dataset D1 with 1 million labelled training examples for classification, and dataset D2 with 100 labelled training examples. Your friend trains a model from scratch on dataset D2. You decide to train on D1, and then apply transfer learning to train on D2. State one problem your friend is likely to find with his approach. How does your approach address this problem? 5

5 Differentiate between soft attention and hard attention. 5

PART B

6 Astronomers are using a linear classifier to classify long exposed CCD images into star, nebula and galaxy. The predicted scores of this linear classifier, during one particular iteration of training is given below 7

Class	Test Image		
	Star	Nebula	galaxy
Star	3.2	1.3	2.2
Nebula	5.1	4.9	2.5
Galaxy	-1.7	2	-3.1

Calculate the softmax loss for Nebula. Find minimum and maximum softmax loss, if there are C classes.

7 Draw the computational graph and calculate the analytical gradients at each node for the following function 7

$$f(w,x) = \frac{1}{1 + e^{-(w_0 x_0 + w_1 x_1 + w_2)}}$$

where $w_0 = 2,\ w_1 = -3, w_2 = -3,\ x_0 = -1,\ x_1 = -2$

8 Consider a CNN implemented with following arrangement. 7

Input 128x128x3

Conv 4- 10, stride 2, pad 0

Conv 9-10,stride 2, pad 2

Pool 2 stride 2, pad 0

Conv 3-5 stride 2, pad 0

FC 5

FC-N denotes fully connected layer with N neuron outputs. Conv M-N indicates convolution layer of size MxMxD, with M filters and D activation volume of previous layer. Pool 2 indicates 2x2 maxpooling layer. Find activation volume and number of parameters at each layer.

9	Write disadvantages of SGD. Explain how ADAM overcome it.	7
10	Imagine you were asked to write a poem in the writing style of John Keats. What kind of network will you use? Draw and explain the structure of identified network with equations.	7
11	You were asked to design an object detection frame work to be used in Google's autonomous car Waymo. The designed framework should be able to detect and identify multiple objects (pedestrians, other vehicles etc.) from images obtained from the camera feed of Waymo. Draw and explain the general structure of the network. Justify your answer.	7
12	Design a network to generate your photo in the style of Leonardo DaVinci'sMonalisa.	7

SYLLABUS

MODUE 1: Introduction to Machine Learning

Introduction: Supervised Vs. Unsupervised Learning, Classification Vs. Regression, Machine Learning Vs. Deep Learning

Machine Learning System Design: Data-driven Approach, Datasets: Training, Testing and Validation Sets, Over fitting and Under fitting, Hyper parameters, K-nearestneighbour classification

Linear classification: Loss function, Multiclass SVM,Softmax classifier. Optimization, Numeric andAnalytic gradients.

MODULE 2: Neural Networks

Deep feedforward networks/ Multilayer perception: Perceptron, activation functions, Example: Learning XOR, Architecture of deep neural network

Back propagation, Gradient-Based Learning.

Convolutional Neural Networks: Convolution, Pooling Layers, spatialarrangement, layer patterns, layer sizing patterns.

MODULE 3: Training Neural Networks

Initialization, batch normalization, Hyper parameter optimization.

Optimization algorithms: SGD, Momentum, Adagrad, RMS Prop, Adam

Regularization methods: L1 and L2 regularization, Early stopping, drop outs, ensembles, data augmentation, Update rules, transfer learning

MODULE 4: CNN architectures

AlexNet, VGG Net, ResNet, Inception Net

Object Detection: RCNN, Fast RCNN, Faster RCNN, YOLO, Mask RCNN

Recurrent Neural Networks: RNN, Bidirectional RNN, LSTM, GRU

MODULE 5: Attention Models, Transformers and Generative Models

Attention: Multimodal attention, Self-Attention

Transformers: BERT and vision transformer

Autoencoders, Variational auto encoders, Generative Adversarial Network

Course Plan

No	Topic	No. of Lectures
1	**Introduction to Machine Learning**	
1.1	Introduction: Supervised Vs. Unsupervised Learning, Classification Vs. Regression, Machine Learning Vs. Deep Learning	1
1.2	Machine Learning System Design: Data-driven Approach, Datasets: Training, Testing and Validation Sets, Over fitting and Under fitting, Hyper parameters, K-nearestneighbour classification	3
1.3	Linear classification: Loss function, Multiclass SVM, Softmax classifier. Optimization, Numeric andAnalytic gradients.	4
2	**Neural Networks**	

2.1	Deep feedforward networks/ Multilayer perception: Perceptron, activation functions, Example: Learning XOR, Architecture of deep neural network	2
2.2	Back propagation, Gradient-Based Learning.	2
2.3	Convolutional Neural Networks: Convolution, Pooling Layers, spatialarrangement, layer patterns, layer sizing patterns.	3
3	**Training Neural Networks**	
3.1	Initialization, batch normalization, Hyper parameter optimization.	2
3.2	Optimization algorithms: SGD, Momentum, Adagrad, RMS Prop, Adam	2
3.3	Regularization methods: L1 and L2 regularization, Early stopping, drop outs, ensembles, data augmentation, Update rules, transfer learning	2
4	**CNN architectures**	
4.1	AlexNet, VGG Net, ResNet, Inception Net	3
4.2	Object Detection: RCNN, Fast RCNN, Faster RCNN, YOLO, Mask RCNN	3
4.3	Recurrent Neural Networks: RNN, Bidirectional RNN, LSTM, GRU	3
5	**Attention Models, Transformers and Generative Models**	
5.1	Attention: Multimodal attention, Self-Attention	3
5.2	Transformers: BERT and vision transformer	3
5.3	Autoencoders, Variational auto encoders, Generative Adversarial Network	4

Reference Books

1. Ian Goodfellow, YoshuaBengio, and Aaron Courville. Deep learning. MIT press,2016.
2. Francois Chollet. Deep learning with Python. Simon and Schuster, 2021.
3. Ivan Vasilev. Advanced Deep Learning with Python: Design and implement advanced next-generation AI solutions using TensorFlow and PyTorch. Packt Publishing Ltd, 2019.
4. C. M. Bishop, Pattern Recognition and Machine Learning, Springer, 2006
5. Michael A Nielsen. Neural networks and deep learning. Determination press, 2015.

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
222EEC022	SIGNAL PROCESSING FOR AUTOMATION	PROGRAM ELECTIVE 4	3	0	0	3

Preamble: This course aims to impart knowledge on thesignal processing and its applications in the field of vehicle automation, process control automation, robotics, and the audio video processing.

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

CO 1	Understand the general principles of automation, sensors and transducers
CO 2	Understand the automotive Protocols and apply the signal processing application in vehicle automation
CO 3	Apply the Signal Processing methods in Process control and Automation
CO 4	Understand the fundamentals of robot and apply the Signal Processing methods in robotics
CO 5	Understand the principles of audio and video signal processing

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	1	3		3	3	
CO2	3	2	3	3	3	3	1
CO3	3	2	3	3	3	3	1
CO4	3	2	2	2	2	3	
CO5	2		1		1	1	

Assessment Pattern:

Bloom's Category	CIE	End Semester Examination
Apply	10	20
Analyse	10	20
Evaluate	20	20
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

Preparing a review article based on peer reviewed original publications (minimum 10publications shall be referred): 15 marks
Course based task/Seminar/Data collection and interpretation: 15 marks
Test paper, 1 no.: 10 marks
Test paper shall include minimum 80% of the syllabus.

End Semester Examination: 60 marks

The end semester examination will be conducted by the College. There will be twoparts; Part A and Part B. Part A contain 5 numerical questions (such questions shallbe useful in the testing of knowledge, skills, comprehension, application, analysis,synthesis, evaluation and understanding of the students), with 1 question from eachmodule, having 5 marks for each question. Students shall answer all questions. PartB contains 7 questions (such questions shall be useful in the testing of overallachievement and maturity of the students in a course, through long answerquestions relating to theoretical/practical knowledge, derivations, problem solvingand quantitative evaluation), with minimum one question from each module of whichstudent shall answer any five. Each question can carry 7 marks. Total duration ofthe examination will be 150 minutes.

Model Question Paper

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

SECOND SEMESTER M. TECH DEGREE EXAMINATION

Program: M.Tech. in EC3 (Signal Processing, Signal Processing & Embedded Systems, Communication Engineering & Signal Processing)

Course Code: 222EEC022

Course Name: Signal Processing for Automation

Max. Marks: 60 Duration: 150 Minutes

Part A

Answer All Questions. Each Carries 5 mark.

1. Differentiate between State space models and Time series models.
2. Explain about the photometric image formation.
3. What are Smart Sensors? Explain the functions of the Components of Smart Sensors.
4. Illustrate the different approaches to SLAM.
5. Compare the Protocols: LIN, CAN and FlexRay.

Part B

Answer any five questions: Each question carries 7 marks.

6. Illustrate the advantages of PLC over PC.
7. With neat sketch explain the functions of a robot.
8. Explain the static characteristics of transducers.
9. With the help of necessary diagrams Explain How can we interface PLC with SCADA.
10. What are the specifications of robots?
11. With necessary diagrams, explain the features and advantages of AUTOSAR Architecture.
12. Explain the key components of a speech recognition system.

Syllabus and Course Plan

Module I :**Introduction to automation (8)**

Introduction to automation, Overview of expert system, Expert system Architecture, Sensor Fundamentals, Sensor classification, Sensor parameters Selection of sensors. Interfacing of Sensors and Signal Conditioning: Change of BIOS and level of signals, Smart Transducers: Smart Sensors, Components of Smart Sensors, General Architecture of Smart Sensors, Evolution of Smart Sensors, Advantages of Smart Sensors.

Module II :**Signal Processing in vehicle Automation** (8)

Overview of automotive subsystems, basic concept and types of automotive Sensors and Transducers- introduction to autonomous vehicles architecture, Automotive Protocols: LIN, CAN, FlexRay, Test, Calibration and Diagnostics tools for networking of electronic systems like ECU Software and Testing Tools, ECU Calibration Tools, AUTOSAR Architecture.

Module III :**Signal Processing in Process control and Automation (10)**

Introduction to Process Modeling: hierarchies. Theoretical model: transfer function, state space models, and time series models. concept of feedback & feed forward control, cascade control, selective control loops, ratio control, feed forward and ratio, split range, selective, override, auctioneering, adaptive and inferential controls. Statistical process control, supervisory control, direct digital control, distributed control, Introduction to Automatic Control: PC based automation. SCADA in process automation. Time Delay Systems and Inverse Response Systems, Special Control Structures, Introduction to Sequence Control, PLC, RLL, Sequence Control. Scan Cycle.

Module IV :Signal Processing in Robotics (8)

Introduction to robotics, Basic components of robotic system. Sensing - Pre-processing – Noise reduction, enhancement of details. Signal Conversion, Introduction to computer vision, Point operators, Linear Filters, More neighborhood operators, Introduction to machine vision system, Overview of SLAM, Different Approaches to SLAM. Introduction to Robot Operating system(ROS).

Module V :**Signal Processing in Audio Video Processing (7)**

Analog video, digital video, time-varying image formation models: three dimensional motion models, geometric image formation, photometric image formation,sampling of video signals, filtering operations. Vocoder- Voice excited channel vocoder, Voice excited and error signal excited LPC vocoders. Adaptive predictive coding of speech, Auditory Modeling. Speech recognition and pattern matching techniques

No	Topic	No. of Lectures
1	**Introduction to automation (8)**	
1.1	Introduction to automation and automated systems, Overview of expert system, Expert system Architecture	**2**
1.2	Fundamentals of sensors, Sensor classification	**1**
1.3	Sensor parameters Selection of sensors. Interfacing of Sensors and Signal Conditioning: Change of BIOS and level of signals,	**2**
1.4	Smart Transducers: Smart Sensors, Components of Smart Sensors, General Architecture of Smart Sensors,	**2**
1.5	Evolution of Smart Sensors, Advantages of Smart Sensors.	**1**
2	**Signal Processing in Vehicle Automation (8)**	
2.1	Overview of automotive subsystems	**1**
2.2	Basic principles and types of automotive Sensors and Transducers-.	**1**
2.3	introduction to autonomous vehicles architecture	**1**
2.4	Intoduction to Automotive Protocols:	**1**
2.5	Automotive Protocols: LIN, CAN, FlexRay, Test, Calibration and Diagnostics tools for networking of electronic systems like ECU Software and Testing Tools, ECU Calibration Tools	**3**
2.6	AUTOSAR Architecture	**1**
3	**Signal Processing in Process control and Automation (10)**	
3.1	Introduction to Process Modeling: hierarchies.	**1**
3.2	Theoretical model: transfer function, state space models, and time series models.	**2**
3.3	concept of feedback & feed forward control, cascade control, selective control loops, ratio control, feed forward and ratio, split range, selective, override, auctioneering, adaptive and inferential controls. Statistical process control, supervisory control, direct digital control, distributed control	**2**
3.4	Introduction to Automatic Control:	**1**

3.5	PC based automation. SCADA in process automation. Time Delay Systems and Inverse Response Systems	**2**
3.6	Special Control Structures, Introduction to Sequence Control, PLC, RLL, Sequence Control. Scan Cycle.	**2**
4	**Signal Processing in Robotics (8)**	
4.1	Introduction to robotics, Basic components of robotic system.	**1**
4.2	Sensing - Pre-processing – Noise reduction	**1**
4.3	Enhancement of details and Signal Conversion in robotic	**1**
4.4	Introduction to computer vision, Point operators, Linear Filters, More neighborhood operators	**2**
4.5	Introduction to machine vision system	**1**
4.6	Overview of SLAM, Different Approaches to SLAM.	**1**
4.7	Introduction to Robot Operating system(ROS).	**1**
5	**Signal Processing in Audio Video Processing (7)**	
5.1	**Overview of** Analog video, digital video	**1**
5.2	Time-varying image formation models: three dimensional motion models,	**1**
53	Geometric image formation, photometric image formation	**1**
5.4	Sampling of video signals, filtering operations.	**1**
5.5	Vocoder- Voice excited channel vocoder, Voice excited and error signal excited LPC vocoders.	**1**
5.6	Adaptive predictive coding of speech, Auditory Modeling.	**1**
5.7	Speech recognition and pattern matching techniques	**1**

Text Books

1. “Anatomy of Automation” – Amber G.H & P.S. Amber, PrenticeHall
2. NikolayKirianaki, Sergey Yurish, Nestor Shpak, VadimDeynega, Data Acquisition and Signal Processing for Smart Sensors, John Wiley & Sons Ltd, 2002.
3. Tao Zhang, Luca Delgrossi, “Vehicle Safety Communications: Protocols, Security and Privacy”, Wiley Publication.
4. Robert Bosch,” Automotive Hand Book”, Fifth edition, SAE Publications.
5. Groover. M.P. Industrial Robotics, technology, programming and application Mc-Graw Hill 2012.

6. S. R.Deb, “Robotics technology and flexible automation”, Tata McGraw Hill publishing company limited, 1994.
7. Bob Connel, Process Instrumentation Applications Manual, McGrawHill, 1996.
8.Ranjan Parekh,Fundamentals of image, audio, and video processing using matlab®: with applications to pattern recognition,CRC Press (Taylor and Francis2021 :
9.Nelson Morgan and Ben Gold, Speech and Audio Signal Processing: Processing and Perception Speech and Music, July 1999, John Wiley & Sons

Reference Books

1. Smart Sensors, Measurement and Instrumentation by Subhas ChandraMukhopadhyay, Springer Book Series.
2. Randy Frank , Understanding Smart Sensors , Second Edition, Artech House sensors library, 2000.
3. Ronald K. Jurgen, “Automotive Electronics Handbook”, Mc -Graw Hill..
3. S. K. Saha, “Introduction to Robotics”, Tata McGraw-Hill Publishing Company Ltd. (2008).
4. Peter Corke, Robotics, Vision and Control: Fundamental Algorithms, Springer Tracts in Advanced Robotics,Volume 118, Second Edition, 2016
5. Seborg, D.E., T.F. Edgar, and D.A. Mellichamp, Process Dynamics and Control, John Wiley , 2004

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
222EEC023	EMBEDDED SYSTEMS AND RTOS	PROGRAM ELECTIVE 4	3	0	0	3

Preamble: The objective of the course is to impart the concepts and architecture of Embedded systems,Realtime systems and Real-time Operating Systems and to make the students capable of designing Real-Time EmbeddedSystems. To achieve this, the architecture and programming of Industry popular 32-bit Microcontroller, ARM Cortex is covered in detail.

Course prerequisites: Nil

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

CO 1	To do hardware/software co-design for embedded systems and to develop skills in analysis, approach, optimization, and implementation of embedded systems.
CO 2	To familiarize with ARM cortex Microcontroller architecture.
CO 3	Apply embedded program optimization skills in designing embedded systems.
CO 4	To learn implementation aspects of real time systems.
CO 5	Apply RTOS concepts in solving multi-tasking embedded applications

Mapping of course outcomes with program outcomes

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

Assessment Pattern

Bloom's Category	End Semester Examination (%)
Apply	40%
Analyse	20%
Evaluate	20%
Create	20%

Mark distribution

Total Marks	CIE	ESE	ESE Duration
100	40	60	2.5 hours

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

Continuous Internal Evaluation Pattern:

Continuous Internal Evaluation: 40 marks

Preparing a review article based on peer reviewed Original publications (minimum 10 publications shall be referred)	15 marks
Course based task/Seminar/Data collection and interpretation	15 marks
Test paper, 1 no. (Test paper shall include minimum 80% of the syllabus.)	10 marks
TOTAL	**40 marks**

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 (such questions shall be useful in the testing of knowledge, skills, comprehension, application, analysis, synthesis, evaluation and understanding of the students). 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.

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 %.

Model Question Paper

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

SECOND SEMESTER M. TECH DEGREE EXAMINATION

Program: M.Tech.in EC3 (Signal Processing, Signal Processing &Embedded Systems, Communication Engineering & Signal Processing)

Course Code: 222EEC023

Course Name: EMBEDDED SYSTEMS AND RTOS

Max. Marks: 60 Duration: 150 Minutes

Part A

Answer All Questions. Each Carries 5 mark.

1. Find out how characters are copied from input to output using interrupts and buffers with the help of a program segment.
2. The content of registers is given as below
   R1 = 0xEF00DE12,
   R2 = 0x0456123F,
   R5 = 4, R6 = 28.
   Find the result in the destination register when the following instructions are executed
   a) LSL R1, #8
   b) ASR R1,R5
   c) ROR R2,R6
3. Design a Data Flow Graph for the block shown below:
   r = a+b-c; s = a*r ; t = b-d; r = d+e;
4. Inspect how the clocks are synchronized if the times are close to each other.
5. With the help of an example, explain that the knowledge of data dependencies can help to use the CPU more efficiently.

Part B

Answer any five questions: Each question carries 7 marks.

6. Evaluate system design using requirements and illustrate the type of design and explain.
7. From the fundamentals, draw the architecture of ARM processor with relevant explanation.
8. Evaluate the different techniques used in software performance optimization.
9. Examine the exponentially distributed fault latency with the condition mean $1/\mu$.
10. Investigate this statement with the help of an example. The timing requirements on a set of process can strongly influence the type of appropriate scheduling.

11. Investigate the Loop transformation techniques for optimization of code.
12. Formulate the working of Engine control unit in detail
    i. Theory of operations and requirements
    ii. Specification
    iii. System Architecture
    iv. Component designing and testing
    v. System integration and testing.

SYLLABUS
Module 1 (8 Hours) **Introduction to embedded system design:** Complex systems and microprocessors– Embedded system design process –Design example: Model train controller- Design methodologies- Design flows – Requirement Analysis – Specifications-System analysis and architecture design – Quality Assurance techniques -Designing with computing platforms – consumer electronics architecture –platform-level performance analysis.
Module 2 (8 Hours) **ARM processor and peripherals:** ARM Architecture Versions – ARM Architecture – Instruction Set – Stacks and Subroutines – Features of the LPC 214X Family – Peripherals – The Timer Unit – Pulse Width Modulation Unit – UART – Block Diagram of ARM9 and ARM Cortex M3 MCU.
Module 3 (8 Hours) **Embedded programming:** Components for embedded programs- Models of programs- Assembly, linking and loading – compilation techniques- Program level performance analysis – Software performance optimization – Program level energy and power analysis and optimization – Analysis and optimization of program size- Program validation and testing.
Module 4 (8 Hours) **Real time systems**: Structure of a Real Time System — Estimating program run times – Task Assignment and Scheduling – Fault Tolerance Techniques – Reliability, Evaluation – Clock Synchronisation.

Module 5 (8 Hours)

Processes and operating systems: Introduction – Multiple tasks and multiple processes – Multirate systems- Pre-emptive real time operating systems- Priority based scheduling- Inter process communication mechanisms – Evaluating operating system performance- power optimization strategies for processes – Example Real time operating systems-POSIX-Windows CE. – Distributed embedded systems – MPSoCs and shared memory multiprocessors. – Design Example – Audio player, Engine control unit – Video accelerator.

Course Plan

Sl. No	Topic	No. of Lectures
1	**Introduction to embedded system design**	
1.1	Complex systems and micro processors	1
1.2	Embedded system design process –Design example: Model train controller- Design methodologies- Design flows – Requirement Analysis – Specifications-System analysis and architecture design – Quality Assurance techniques	5
1.3	Designing with computing platforms – consumer electronics architecture –platform-level performance analysis	2
2	**ARM processor and peripherals**	
2.1	ARM Architecture Versions – ARM Architecture - Instruction Set – Stacks and Subroutines	4
2.2	Features of the LPC 214X Family – Peripherals – The Timer Unit – Pulse Width Modulation Unit – UART	2
2.3	Block Diagram of ARM9 and ARM Cortex M3 MCU.	2
3	**Embedded programming**	
3.1	Components for embedded programs- Models of programs- Assembly, linking and loading – compilation techniques	3
3.2	Program level performance analysis – Software performance optimization – Program level energy and power analysis and optimization	2
3.3	Analysis and optimization of program size- Program validation and testing	3
4	**Real time systems**	
4.1	Structure of a Real Time System	1

4.2	Estimating program run times – Task Assignment and Scheduling	3
4.3	Fault Tolerance Techniques – Reliability, Evaluation	2
4.4	Clock Synchronisation.	2
5	**Processes and operating systems**	
5.1	Multiple tasks and multiple processes – Multirate systems- Pre-emptive real time operating systems	1
5.2	Priority based scheduling- Inter process communication mechanisms	1
5.3	Evaluating operating system performance- power optimization strategies for processes	2
5.4	Example Real time operating systems-POSIX-Windows CE	1
5.5	Distributed embedded systems – MPSoCs and shared memory multiprocessors.	1
5.6	Design Example – Audio player, Engine control unit – Video accelerator.	2

Text Books

1. Marilyn Wolf (2012): "Computers as Components - Principles of Embedded Computing System Design", 3rd Edition: Morgan Kaufmann Publisher (An imprint from Elsevier).
2. Simon David. E (2007): "An Embedded Software Primer", 1st Edition, Fifth Impression: Addison Wesley Professional.
3. Prasad K.V.K.K. (2005): "Embedded Real-Time Systems: Concepts, Design & Programming", Dream Tech Press.
4. Muhammad Ali Mazidi, Shujen Chen, Sarmad Naimi, Sepehr Naimi, "Freescale ARM Cortex-M Embedded Programming Using C Language"

Reference Books

1. Lyla B.Das (2013): "Embedded Systems: An Integrated Approach", Pearson Education.
2. Valvano Jonathan W (2012): "Embedded Microcomputer Systems Real Time Interfacing", 3rd Edition: Cengage Learning.
3. Buhr Raymond J.A., Bailey Donald L (1999): "An Introduction to Real-Time Systems- From Design to Networking with C/C++", Prentice Hall.
4. Krishna C.M., Shin Kang G. (1997): "Real-Time Systems", International Editions, Noida: Mc Graw Hill.
5. Iyer Sriram V, Gupta Pankaj (2004): "Embedded Real Time Systems Programming", Noida: Tata Mc Graw Hill.
6. Raj Kamal, "Embedded Systems Architecture Programming and Design": 2nd Edition; Tata McGraw Hill

SEMESTER II

INTERDISCIPLINARY ELECTIVE

CODE	COURSE	CATEGORY	L	T	P	CREDIT
222EEC083	AUTOMOTIVE ELECTRONICS	INTER-DISCIPLINARY ELECTIVE	3	0	0	3

Preamble: The purpose of this course is to provide an awareness of Automotive Electronics. As an outcome of the course the students will be aware of the technical details of Electronics Engineering in Automotive industry, the current trends and challenges.

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

CO#	CO
CO1	Understand the fundamentals of vehicle electronic systems and integration of electronic components in vehicle system architecture.
CO2	Understand the various communication technologies on board vehicles
CO3	Understand the working of various control algorithms implemented in vehicles for the purpose of automation
CO4	Apply the knowledge of electronics for safety and security in vehicle automation
CO5	Understand the emerging trends in automotive electronics

Program Outcomes:

PO#	PO
PO1	An ability to independently carryout 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's 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 tools to model, analyze 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	M	L	L	L	L	M	
CO2	M	L	L	L	L	M	
CO3	M	L	L	L	L	M	
CO4	M	L	L	L	L	M	
CO5	M	L	L	L	L	M	

Assessment Pattern

Bloom's Category		**Continuous Assessment Tests**	**End Semester Examination**
		Test [%] (10 marks)	**University Exam[%] (60 marks)**
Remember	K1	20	20
Understand	K2	60	60
Apply	K3	20	20
Analyse	K4		
Evaluate			
Create			

Mark distribution

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

Continuous Internal Evaluation Pattern (Elective):

Preparing a review article based on peer-reviewed original publications(minimum10 publications shall be referred): 15 marks
Course-based task/Seminar/Data collection and interpretation: 15marks
(Group projects not permitted)
Test paper, 1 No. : 10 marks
Test paper shall include a minimum of 80% of the syllabus.

End Semester Examination Pattern:

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, with a minimum of one question from each module of which students should answer any five. Each question can carry 7marks.

Model Question Paper

PAGES: 1 **Slot**

Name: **Reg No:**

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

SECOND SEMESTER M.TECH DEGREE EXAMINATION, MONTH & YEAR

Course Code: 222EEC083

Course Name: A u t o m o t i v e E l e c t r o n i c s

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

PART A

Answer all Questions. Each question carries 5 marks

1. a) State the functions of Motronic engine-management.
   b) Explain the working principle of fuel injector.
2. Illustrate basic CAN module with block diagram and explain.
3. Explain the principle of on board diagnostics in automotive electronics.
4. Illustrate the concept of anti slip regulation in automotive safety systems.
5. Explain the concept of V2V communication.

(5x5=25Marks)

PART B

Answer any 5 questions. Each question carries 7 marks

6. Illustrate Electronic ignition system configuration with suitable diagram.
7. Justify the need for a communication network in a vehicle.
8. a) Differentiate between Cruise control and Traction Control. (4)
   b) Explain the concept of Actuator Limiting. (3)
9. Illustrate the principle of interfacing an A/D converter with a temperature sensor. State the specifications of the modules used.
10. a) Explain blind spot detection in vehicles. (4)
    b) Identify the pedestrian safety measures available in modern cars (3)
11. Illustrate the autonomous driving system architecture with block diagram.
12. Explain the working of hybrid vehicles with a block diagram,.

(5x7=35Marks)

Syllabus

Module 1: Introduction to Automotive Electronics (7Hrs)
Overview of vehicle electronic systems,Integration of electronic components and systems in vehicles, Vehicle System Architecture – Sensors – Actuators – Embedded processors and micro-controllers, Introduction to Electronic Instrumentation for sensors: temperature, distance, velocity, speedometer, anti-collision. limitations, topologies and processing for sensors, DA/AD converters, Interfacing ADC/DAC to peripherals and sensors

Module 2: Automotive Communications Systems (7Hrs)
Introduction to communications standards, Introduction to networks, safety critical issues and reliability, Communication protocols for automotive applications, CAN- protocol layers, content based addressing, Hardware- basic CAN module, Basic block level working principle of LIN, MOST, Bluetooth & FlexRay, Telematics for automotive applications, GPRS, GPS in automotive environment

Module 3: Automotive Control and Power Systems (7Hrs)
ECU – Electronic Engine Control, Electronic control methods (analog and digital), Stability algorithms for control-cruise control, traction control, Actuator limiting, wind-up and gain scheduling. Energy management strategies: regenerative braking, start-stop, torque boost, Sensing and control systems, Automotive Diagnostics- OBD – Onboard Diagnostics

Module 4: Automotive Safety Systems and ADAS (7Hrs)
Introduction to safety systems, Passive system electronics: Airbag and sensors, Active systems electronics: Anti lock braking system (ABS), Electronic Stability Program (ESP), Anti-slip regulation (ASR), Driver Assistance Systems**:** Advanced active systems electronics: ACC , Active safety system applications: lane detection, blind spot, crash avoidance control electronics, Basics of ADAS, Power Steering, Automatic climate control

Module 5: Advancements in automotive electronics (7Hrs)
Introduction to Autonomous driving-system architecture overview, Navigation systems –VANET, vision intelligence, computational intelligence, smart traffic systems, security, EV**-** classification, benefits and challenges, Basic concepts and challenges of Hybrid vehicles, fuel cell powered vehicles.

Text Books:

1. William B.Ribbens, "Understanding Automotive Electronics", 6th Edition, Elsevier Publishing.
2. Robert Bosch Gmbh (Ed.) Bosch Automotive Electrics and Automotive Electronics Systems and Components, Networking and Hybrid Drive, 5th edition, Springer Vieweg, John Wiley Sons.

References:

1. Hybrid & Electric Vehicles -A CRC Press FREEBOOK
2. Creating Autonomous Vehicle Systems -SYNTHESIS LECTURES ON COMPUTER SCIENCE MORGAN & CLAYPOOL PUBLISHERS
3. A Progressive Review: Emerging Technologies for ADAS Driven Solutions- Jaswanth Nidamanuri , Chinmayi Nibhanupudi, Rolf Assfalg, and Hrishikesh Venkataraman, IEEE TRANSACTIONS ON INTELLIGENT VEHICLES, VOL. 7, NO. 2, JUNE 2022
4. Hillier's Fundamentals of Motor Vehicle Technology5th Edition Book 3,V.A.W. Hillier & David R. Rogers

Course Plan

	Topic	No.of Lectures
	Module 1: Introduction to Automotive Electronics (7Hrs)	
1.1	Overview of vehicle electronic systems	1
1.2	Integration of electronic components and systems in vehicles - Description of VSA- Sensors – Actuators- Embedded processors and micro controllers	1
1.3	Sensors in detail: temperature, distance, velocity, speedometer, anti-collision, limitations, topologies and processing for sensors	2
1.4	DA/AD converters,	1
1.5	Interfacing ADC to peripherals and to sensors	1
1.6	Interfacing DAC to peripherals and to sensors	1
	Module 2: Automotive Communications Systems (7Hrs)	
2.1	Introduction to communications standards , networks, safety critical issues and reliability	1
2.2	Communication protocols for automotive applicationCAN	2
2.3	Basic block level working principle of LIN, MOST, Bluetooth, & FlexRay	2
2.4	Telematics for automotive applications	1
2.5	GPRS, GPS for use in and automotive environment	1
	Module 3: Automotive Control and Power Systems (7Hrs)	
3.1	ECU, Electronic control methods (analog and digital)	1
3.2	Stability algorithms for control (cruise control, traction control)	2
3.3	Actuator limiting, wind-up, gain scheduling	1
3.4	Energy management strategies: regenerative braking, start-stop, torque boost, Sensing and control systems	2
3.5	Automotive diagnostics-OBD	1
	Module 4: Automotive Safety Systems and ADAS (7Hrs)	
4.1	Introduction to safety systems: Passive and Active systems electronics.	1
4.2	Antilock-braking system (ABS), Electronic Stability Program (ESP), Anti-slip regulation (ASR)	1
4.3	Driver Assistance Systems: Advanced active systems electronics: ACC, Basics of ADAS	2
4.4	Active safety system applications: lane detection, blind spot, crash avoidance control electronics	2
4.5	Power Steering , Automatic climate control	1

	Module 5: Advancements in automotive electronics (7Hrs)	
5.1	Introduction to Autonomous driving-system architecture-overview	1
5.2	Navigation systems, VANET,.vision intelligence, computational intelligence	2
5.3	Smart traffic systems, security	**1**
5.4	Basics of EV- classification, benefits, challenges	**1**
5.5	Basic concepts and challenges of Hybrid vehicles, fuel cell powered vehicles	**2**

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
222EEC084	MEMS AND SENSORS	INTERDISCIPLINARY ELECTIVE	3	0	0	3

Course Objectives

- Introduces students to the need of rapidly emerging, area of MEMSand microsystem in engineeringand its applications in sensor technology
- Enable the students to understand the various sensing and actuation mechanisms.

Prerequisite: nil

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

CO1	Identify structural and sacrificial materials for MEMS
CO2	Describe the fabrication steps in designing of various MEMS devices.
CO3	Apply principles for the design of Sensor and actuators
CO4	Apply MEMS for different applications in various fields of engineering

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	*PO5*
CO1					
CO2					
CO3					
CO4					

Assessment Pattern

Bloom'sCategory	Continuous Assessment Tests		End Semester Examination [%] (60Marks)
		Test1 [%] (10Marks)	
Remember		10	20
Understand		20	40
Apply		10	20
Analyse		10	20
Evaluate			
Create			

Mark distribution

Total Marks	CIE (Marks)	ESE (Marks)	ESE Duration
100	40	60	2.5 hours

Continuous Internal Evaluation: 40 marks

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

Course based task/Seminar/Micro project : 15 marks

Test paper 1 no. : 10 marks

Test paper shall include minimum 80% of the syllabus.

End Semester Examination: 60 marks

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 (such questions shall be useful in the testing of knowledge, skills, comprehension, application, analysis, synthesis, evaluation and understanding of the students). 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.

SYLLABUS

1	**MODULE I**

Introduction: Introduction to MEMS and Microsystems, MEMS Classification, MEMS versus Microelectronics, Applications of MEMS in Various Industries, Some Examples of Microsensors, Microactuators, and Microsystems, Materials for MEMS, Laws of Scaling in miniaturization

2	**MODULE II**

MEMS Fabrication: Structure of Silicon, Single Crystal Growth Techniques, Photolithography, Oxidation, Diffusion, Ion Implantation, Physical Vapor Deposition, Chemical Vapor Deposition, Bulk Micromachining: Overview of Etching, Isotropic and Anisotropic Etching, Wet Etchants, Etch Stop Techniques, Dry Etching, Surface Micromachining, LIGA, SLIGA, Wafer Bonding, Electroplating

3	**MODULE III**

Microsensors and Microactuators: Basic Modeling Elements in Mechanical, Electrical and Thermal Systems, Types of Beams: Cantilevers, Bridges, Fixed-Guided beams, Electrostatic sensing and Actuation: Parallel plate capacitor, Applications of parallel plate capacitors: Inertial sensor, Pressure sensor, Flow sensor, Parallel plate Actuators, Piezoresistive Sensors: Origin and Expressions of Piezoresistivity, Piezoresistive Sensor Materials, Applications of Piezoresistive Sensors, Piezoelectric Sensing and Actuation, Thermal Sensing and Actuation: Sensors and Actuators based on Thermal Expansion, Thermocouples, Thermoresistors, Shape Memory Alloy, Applications: Inertial sensors, Flow sensors, Infrared sensors

4	**MODULE IV**

Layout, Simulation Tools, Packaging and Characterization techniques: Introduction of layout, Simulation Tools, General considerations in Packaging , Bonding techniques for MEMS and Various Characterization Techniques for MEMS Devices

5	**MODULE V**

Advances in MEMS:RF-MEMS: MEMS devices for RF Applications: RF MEMS Switches and their applications, High-Q Capacitors and Inductors and Their

Applications in RF Circuits, Overview of Optical MEMS , Chemical-Bio MEMS and Nanoelectromechanical Systems

Text books

- MEMS and Microsystems design and manufacture by Tai-Ran Hsu, Tata McGraw Hill.
- MEMS by N. P. Mahalik, Tata McGraw Hill.
- Foundations of MEMS by Chang Liu, Pearson Prentice Hall.

Reference books

- Sensors and Transducers by M. J. Usher, McMillian Hampshire.
- Analysis and Design Principles of MEMS Devices by Minhang Bao, Elsevier.
- Fundamentals of Microfabrication by M. Madou, CRC Press.
- Microsensors by R.S. Muller, Howe, Senturia and Smith, IEEE Press.
- Semiconductor Sensors by S. M. Sze, Willy Inderscience Publications.

COURSE CONTENTS AND LECTURE SCHEDULE

No.		No. of Hours
	MODULE 1	
1.1	Introduction to MEMS and Microsystems, MEMS Classification, MEMS versus Microelectronics,	1
1.2	Applications of MEMS in Various Industries, Some Examples of Microsensors, Microactuators, and Microsystems	1
1.3	Materials for MEMS,	2
1.4	Laws of Scaling in miniaturization	1
	MODULE II	
2.1	Structure of Silicon, Single Crystal Growth Techniques,	1
2.2	Photolithography, Oxidation,	1
2.3	Diffusion, Ion Implantation,	1
2.4	Physical Vapor Deposition, Chemical Vapor Deposition,	1
2.5	Bulk Micromachining: Overview of Etching, Isotropic and Anisotropic Etching,	1
2.6	Wet Etchants, Etch Stop Techniques, Dry Etching	1

2.7	Surface Micromachining	1
2.8	LIGA, SLIGA	2
2.9	Wafer Bonding, Electroplating	1
MODULEIII		
3.1	Microsensors and Microactuators: Basic Modeling Elements in Mechanical, Electrical and Thermal Systems,	1
3.2	Types of Beams: Fixed-Free (Cantilevers), Fixed-Fixed (Bridges), Fixed-Guided beams,	1
3.3	Electrostatic sensing and Actuation: Parallel plate capacitor,	1
3.4	Applications of parallel plate capacitors: Inertial sensor,	1
3.5	Pressure sensor, Flow sensor, Parallel plate Actuators,	1
3.6	Piezoresistive Sensors: Origin and Expressions of Piezoresistivity, Piezoresistive Sensor Materials,	1
3.7	Applications of Piezoresistive Sensors,	1
3.8	Piezoelectric Sensing and Actuation,	1
3.9	Thermal Sensing and Actuation: Sensors and Actuators based on Thermal Expansion,	1
3.10	Thermocouples, Thermoresistors,	1
3.11	Shape Memory Alloy, Applications: Inertial sensors, Flow sensors, Infrared sensors	2
MODULEIV		
4.1	Introduction of layout, Simulation Tools,	1
4.2	General considerations in Packaging and bonding techniques in MEMS	2
4.3	Various Characterization Techniques for MEMS Devices	1
MODULEV		
5.1	Advances in MEMS: RF-MEMS: MEMS devices for RF Applications:	1
5.2	RF MEMS Switches and their applications,	1

5.3	High-Q Capacitors and Inductors and Their Applications in RF Circuits,	1
5.4	Overview of Optical MEMS ,	1
5.5	Chemical-Bio MEMS and Nanoelectromechanical Systems	1

Model Question Paper

A P J Abdul Kalam Technological University
Second Semester M.Tech Degree Examination
Course: 222EEC084MEMS and Sensors
Time: 150 Minutes Max. Marks: 60

PART A
Answer All Questions

1	Mention the criteria for selecting materials for the masks used in etching. List four materials used as masks.	5
2	Define etch stop? List different methods used to stop etching and explain one with sketches	5
3	Explain with neat sketches the type of mechanical beams and boundary conditions associated with supports	5
4	State the various levels of micro system packaging	5
5	With neat sketches explain the construction and working of a shunt type RF MEMS switch.	5

PART B
Answer any five question

6	A silicon substrate is doped with phosphorus ions at 100 KeV. Assume the maximum concentration after the doping is 30 x $10^{18}/cm^3$. Find: (a) the dose, Q, (b) the dopant concentration at the depth 0.15 μm, (c) the depth at which the dopant concentration is at 0.15% of the maximum value. (Given: Rp = 135 nm and ΔRp = 53.5 x 10^{-7}cm at 100 KeV energy level).	*7*
7	Explain in the light of scaling, assuming a 10 times reduction of size of the actuator. Which of the electrostatic and electromagnetic forces are best suited for micro device actuation and why?	*7*
8	Explain the purpose of micro cantilevers in MEMS systems. What is the relevance of Spring constant (k) of the mechanical structure in the microsystems.	*7*

9	Explain the principle of operation of the following micro sensors (i) Comb drives (ii) Shape Memory Alloys	*7*
10	Explain the challenges involved in BioMEMS. List three applications of BioMEMS.	*7*
11	Explain Various bonding techniques associated with MEMS and their implications on packaging	*7*
12	Explain the LIGA process associated with MEMS fabrication with suitable sketches	*7*

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
222EEC085	NANO MATERIALS FOR DRUG DELIVERY	INTERDISCIPLINARY ELECTIVE	3	0	0	3

Preamble: To inspire the students with interest to investigate role of new nanomaterials and devices drug delivery.

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

CO 1	Familiarize the concepts of nano materials for drug delivery
CO 2	Investigate the use of nano materials for drug delivery
CO 3	Investigate the use of nanodevices for drug targeting

Mapping of course outcomes with program outcomes

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

Assessment Pattern

Bloom's Category	End Semester Examination
Apply	20
Analyse	40
Evaluate	
Create	

Mark distribution

Total Marks	CIE	ESE	ESE Duration
100	40	60	2.5 hours

Continuous Internal Evaluation Pattern

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.

End Semester Examination Pattern:

There will be two parts; Part A and Part B. Part A will contain 5 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 with minimum one question from each module of which student should answer any five. Each question can carry 7 marks.

Syllabus and course plan

No	Topic	No. of Lectures
1	**Nanomedicines**	
1.1	Basic concepts in the design, specification and desired features of nanomedicine and general process steps involved in their preparation Nanomedicines for various disease conditions: infectious diseases, neurological diseases, pulmonary disorders, cardiovascular diseases	4
1.2	cancer: nano-chemotherapy, - radiation therapy, - immunotherapy, -nuclear medicine therapy, -photodynamic therapy, - photothermal and RF hyperthermia therapy, scintillation therapy, gene-therapy: DNA, RNA delivery. Theranostic nanomedicines: Basic concept, multifunctional nanomedicines for theranosis	4
2	**Drug Delivery Systems**	
2.1	Administration Routes: Oral Drug Delivery, Features of Gastrointestinal tract (GI), Targeting of drugs in the GI tract.	4
2.2	Design and fabrication of oral systems - Dissolution controlled, diffusion controlled, osmotic controlled, chemically controlled release, Intravenous Drug Delivery - Factors controlling pharmacokinetics of IV formulations, Concept of opsonization	4
3	**Drug Delivery Devices**	
3.1	Transdermal Drug Delivery, Structure of human skin and theoretical advantages of the transdermal route, Transdermal penetration of drugs, adhesion, bioactivity.	4
3.2	Intranasal Drug Delivery - Nasal physiology and intranasal Drug Administration, Nasal drug delivery devices, Ocular Drug Delivery devices; Miscellaneous Drug Delivery	4
4	**Advanced Drug Delivery**	
4.1	Concept of Drug Targeting; Prodrug and Bioconjugation; Nanoscale Drug Delivery Systems - Advantages of nanodrug delivery – Improvements in pharmacokinetics, bioavailability, biodistribution; Concepts of controlled and sustained drug delivery, How nanoparticles pass barriers; Surface modification of nanoparticulate carriers	4

4.2	Nanocarriers for drug delivery - Lipid based pharmaceutical nanoparticles – Liposomes, Solid Lipid Nanoparticles, Nanostructured Lipid Carriers, Cubosomes and Hexosomes, Polymeric Micelles, DNA- Based Nanomaterials, Dendrimers, Polymeric nanoparticles, Inorganic nanoparticles, Hydrogels for controlled drug delivery	4
5	**Active and passive nanocarriers**	
5.1	Concept of targeting, Site Specific Drug delivery utilizing Monoclonal Antibodies, Peptides, Other Biomolecules, Stimuli-Responsive Target Strategies; Implants; Protein and Peptide Drug Delivery; Delivery of Nucleic Acids	3
5.2	Delivery of Vaccines; Aptamers in Advanced Drug Delivery; Biomimetic Self-Assembling Nanoparticles	2
5.3	Nanotechnology Challenges; Regulatory Considerations and Clinical Issues in Advanced Drug Delivery	3

Books-

1. Drug Delivery Systems, Pieter Stroeve and MortezaMahmoudi, World Scientific Series: From
2. Biomaterials towards Medical Devices, Vol I, 2018.
3. Nanoparticulates as Drug Carriers, Vladimir Torchillin, Imperial College Press, 2006
4. Drug Delivery Systems, Third Edition, Vasant V Ranade, John B. Cannon, by CRC Press, 2011