M.TECH IN SIGNAL PROCESSING (LSP)

Choice Based Credit System (CBCS) and Outcome Based Education (OBE)

(Effective from the academic year 2022-23)

Semester- 1

Advanced Engineering Mathematics			
Course Code	**22LSP11**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40 hours of Theory	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

- **To learn principles of advanced engineering mathematics through linear algebra and calculus of variations.**
- **To understand probability theory and random process that serve as an essential tool for applications of electronics and communication engineering sciences.**

Module-1	
Teaching-Learning Process	Chalk and Talk / Power Point Presentations.

Module-2	
Teaching-Learning Process	Chalk and Talk / Power Point Presentations.

Module-3	
Teaching-Learning Process	Chalk and Talk / Power Point Presentations.

Module-4	
Teaching-Learning Process	Chalk and Talk / Power Point Presentations.

Module-5	
Teaching-Learning	Chalk and Talk / Power Point Presentations.

Process	

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks or one Skill Development Activity of 40 marks**
   to attain the COs and POs

The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Books

1. David C.Lay, Steven R.Lay and J.J.McDonald: "Linear Algebra and its Applications", 5th Edition, Pearson Education Ltd., 2015
2. Elsgolts, L.:"Differential Equations and Calculus of Variations", MIR Publications 3rd Edition, 1977.
3. T.Veerarajan: "Probability, Statistics and Random Process", 3rd Edition, Tata Mc-Graw Hill Co., 2016.
4. Gilbert Strang: Introduction to Linear Algebra, 5th Edition, Wellesley-Cambridge Press., 2016
5. Richard Bronson: "Schaum's Outlines of Theory and Problems of Matrix Operations", McGraw-Hill, 1988.
6. Scott L.Miller,Donald G.Childers: "Probability and Random Process with application to Signal Processing", Elsevier Academic Press, 2nd Edition,2013.
7. E. Kreyszig, "Advanced Engineering Mathematics", 10th edition, Wiley, 2015.

Web links and Video Lectures (e-Resources):

1. **http://nptel.ac.in/courses.php?disciplineId=111**
2. **http://www.class-central.com/subject/math(MOOCs)**
3. **http://ocw.mit.edu/courses/mathematics/**
4. **www.wolfram.com**

Skill Development Activities Suggested

- Practice more number of complex problems

Course outcome (Course Skill Set):

At the end of the course the student will be able to :

Sl. No.	Description	Blooms Level
CO1	Understand vector spaces, basis, linear transformations and the process of obtaining matrix of linear transformations arising in magnification and rotation of images.	Understand
CO2	Apply techniques of constrained optimization for problems arising in control system analysis, signals and systems.	Understand
CO3	Apply the techniques of inner product , orthogonal vectors , Q.R decomposition and singular value decomposition for data compression.	Analyze
CO4	Learn the idea of random variables (discrete/continuous) and probability distributions in analyzing the probability models arising in control systems and system communications.	Understand
CO5	Analyze random process through parameter-dependent variables in various random processes.	Analyze

Advanced Digital Signal Processing			
Course Code	**22LSP12**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:2:0	SEE Marks	50
Total Hours of Pedagogy	40 hours Theory + 10-12 Lab slots	Total Marks	100
Credits	04	Exam Hours	03

Course objectives:

- Understand Multirate digital signal processing principles and its applications.
- Estimate the various spectral components present in the received signal using different spectral estimation methods such as Parametric and Nonparametric.
- Design and implement an optimum adaptive filter using LMS and RLS algorithms.
- Understand the concepts and mathematical representations of Wavelet transforms.

MODULE-1	
Review of transforms, Z-Transform, Discrete Time Fourier Transform (DTFT), Discrete Fourier Transform (DFT), Discrete Cosine Transform (DCT), Short Time Fourier Transform (STFT).	
Teaching-Learning Process	Chalk and Talk / Power Point Presentations.

MODULE-2	
LTI systems as frequency selective filters, Invertibility of LTI systems, Design of digital filters by placement of poles, and zeros, FIR filter structures, IIR filter structures, Design of FIR filters, Linear Phase Systems, Window method, Frequency sampling method, Finite word length effects, Design of IIR filters, Pole zero placement, Impulse invariance, Bilinear Z transformation, Finite word length effects	
Teaching-Learning Process	Chalk and Talk / Power Point Presentations.

MODULE-3	
Linear prediction and Optimum Linear Filters: Random signals, Correlation Functions and Power Spectra, Innovations Representation of a Stationary Random Process. Forward and Backward Linear Prediction. Solution of the Normal Equations. The Levinson-Durbin Algorithm. Properties of the Linear Prediction-Error Filters.	
Teaching-Learning Process	Chalk and Talk / Power Point Presentations.

MODULE-4	
Adaptive filters: Applications of Adaptive Filters-Adaptive Channel Equalization, Adaptive noise cancellation, Linear Predictive coding of Speech Signals, Adaptive direct form FIR filters-The LMS algorithm, Properties of LMS algorithm. Adaptive direct form filters- RLS algorithm.	
Teaching-Learning Process	Chalk and Talk / Power Point Presentations.

MODULE 5	
Power Spectrum Estimation: Non parametric Methods for Power Spectrum Estimation - Bartlett Method, Welch Method, Blackman and Tukey Methods. Parametric Methods for Power Spectrum Estimation: Relationship between the auto correlation and the model parameters, Yule and Walker methods for the AR Model Parameters, Burg Method for the AR Model parameters, Unconstrained least-squares method for the AR Model parameters, Sequential estimation methods for the AR Model parameters, ARMA Model for Power Spectrum Estimation.	
Teaching-Learning	Chalk and Talk / Power Point Presentations.

Process	

PRACTICAL COMPONENT OF IPCC*(May cover all / major modules)*

Sl.NO	Experiments
1	Write a program in Matlab implement the Levinson – Durbin algorithm of prediction
2	Write a program in Matlab to implement LMS adaptive filter
3	Write a program in Matlab to implement RLS filter
4	Write a program in Matlab to compute the power spectrum estimation using Bartlett method,Welch method, Blackman and Tukey method
5	Write a program in Matlab to estimate AR model parameters
6	Write a program in Matlab to estimate ARMA model parameters
7	Write a program in Matlab to compress the signal using the DWT
8	Write a program in Matlab to estimate the signal from corrupted signal , also compute the SNR
9	Demonstration Experiments (For CIE) if any
10	**Design a simulink using Matlab to implement LMS and RLS filter**
11	**Design a simulink using Matlab to implement power spectrum estimation**

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

CIE for the theory component of IPCC

1. Two Tests each of **20 Marks**

2. Two assignments each of **10 Marks/One Skill Development Activity of 20 marks**
3. Total Marks of two tests and two assignments/one Skill Development Activity added will be CIE for 60 marks, marks scored will be proportionally scaled down to **30 marks**.

CIE for the practical component of IPCC

- On completion of every experiment/program in the laboratory, the students shall be evaluated and marks shall

be awarded on the same day. The**15 marks** are for conducting the experiment and preparation of the laboratory record, the other **05 marks shall be for the test** conducted at the end of the semester.

- The CIE marks awarded in the case of the Practical component shall be based on the continuous evaluation of the laboratory report. Each experiment report can be evaluated for 10 marks. Marks of all experiments' write-ups are added and scaled down to 15 marks.
- The laboratory test at the end /after completion of all the experiments shall be conducted for 50 marks and scaled down to 05 marks**.**

Scaled-down marks of write-up evaluations and tests added will be CIE marks for the laboratory component of IPCC for **20 marks**.

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SEE for IPCC

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (duration 03 hours)

1. The question paper will be set for 100 marks and marks scored will be scaled down proportionately to 50 marks.
2. The question paper will have ten questions. Each question is set for 20 marks.
3. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
4. The students have to answer 5 full questions, selecting one full question from each module.

The theory portion of the IPCC shall be for both CIE and SEE, whereas the practical portion will have a CIE component only. Questions mentioned in the SEE paper shall include questions from the practical component).

- The minimum marks to be secured in CIE to appear for SEE shall be the 15 (50% of maximum marks-30) in the theory component and 10 (50% of maximum marks -20) in the practical component. The laboratory component of the IPCC shall be for CIE only. However, in SEE, the questions from the laboratory component shall be included**.** The maximum of 04/05 questions to be set from the practical component of IPCC, the total marks of all questions should not be more than the 20 marks.
- SEE will be conducted for 100 marks and students shall secure 40% of the maximum marks to qualify in the SEE. Marks secured will be scaled down to 50. (Student has to secure an aggregate of 50% of maximum marks of the course(CIE+SEE)

Suggested Learning Resources:

Books

1. **'**Digital Signal Processing, Principles, Algorithms and Applications**'**, John G. Proakis, Dimitris G.Manolakis, Pearson, Fourth edition, 2007
2. **'**Insight into Wavelets- from Theory to Practice**'**, K P Soman, Ramachandran, Resmi, PHI, Third Edition, 2010

Web links and Video Lectures (e-Resources):

https://www.mooc.org/
https://onlinecourses.nptel.ac.in/

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

Mini project in the area of digital signal processing using modern tools like MATLAB, Python, scilab

Course Outcomes

At the end of the course the student will be able to :

Sl. No.	Description	Blooms Level
CO1	Able to understand and analyze the linear prediction and optimum linear filters	L1 L2 Ll3
CO2	Able to understand and analyze LMS and RLS adaptive filter algorithms	L2 L4
CO3	Able to analyze and implement the parametric and non parametric methods of power spectrum estimation	L2 L4

Pattern recognition and Machine Learning for Data Processing			
Course Code	**22LSP13**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:2	SEE Marks	50
Total Hours of Pedagogy	40 hours Theory + 10-12 slots for Skill Development Activities	Total Marks	100
Credits	04	Exam Hours	03

Course Learning objectives:

- To understand the basic theory underlying machine learning.
- To be able to formulate machine learning problems corresponding to different applications.
- To understand a range of machine learning algorithms along with their strengths and weaknesses.
- To be able to apply machine learning algorithms to solve problems of moderate complexity. To apply the algorithms to a real-world problem, optimize the models learned and report on the expected accuracy that can be achieved by applying the models.

Module-1

Introduction, concept Learning :Well posed learning problems ,Designing a Learning system

Perspective and Issues in Machine Learning.

Concept Learning: Concept learning task, Concept learning as search ,Find-S algorithm, Version space, Candidate Elimination algorithm, Inductive Bias

Teaching-Learning Process	Chalk and Talk / Power Point Presentations.

Module-2

Supervised Learning: Linear Regression (Gradient Descent, Normal Equations), Weighted Linear Regression (LWR), Logistic Regression, Perceptron, Newton's Method, KL-divergence, (cross-)Entropy.

Teaching-Learning Process	Chalk and Talk / Power Point Presentations.

Module-3

Natural Gradient, Exponential Family and Generalized Linear Models, Generative Models (Gaussian Discriminant Analysis, Naive Bayes), Kernel Method (SVM, Gaussian Processes), Tree Ensembles (Decision trees, Random Forests, Boosting and Gradient Boosting), Learning Theory, Regularization, Bias-Variance Decomposition and Tradeoff, Concentration Inequalities, Generalization and Uniform Convergence, VC-dimension,

Teaching-Learning Process	Chalk and Talk / Power Point Presentations.

Module-4

Deep Learning: Neural Networks, Backpropagation, Deep Architectures, Unsupervised Learning, K-means, Gaussian Mixture Model (GMM), Expectation Maximization (EM), Variational Auto-encoder (VAE), Factor Analysis, Principal Components Analysis (PCA), Independent Components Analysis (ICA), Reinforcement Learning (RL) : Markov Decision Processes (MDP), Bellmans Equations, Value Iteration and Policy Iteration, Value Function Approximation, Q-Learning,

Teaching-Learning Process	Chalk and Talk / Power Point Presentations.

Module-5

Application: Advice on structuring an ML project, Evaluation Metrics, Missing data techniques and tracking, Special Topic: Computer Vision. Special Topic: NLP

Special topic: Machine listening and Music Information Retrieval, Special Topic: Speech, Special Topic: Compressive Sensing, Special topics: Array processing, beam forming, independent component analysis, MIMO/SIMO models, under-constrained separation, spectral factorizations.

Teaching-Learning Process	Chalk and Talk / Power Point Presentations.

Assessment Details (both CIE and SEE)

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Continuous Internal Evaluation:

3. Three Unit Tests each of **20 Marks**
4. Two assignments each of **20 Marks** or **one Skill Development Activity of 40 marks** to attain the COs and POs

The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

6. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
7. The question paper will have ten full questions carrying equal marks.
8. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
9. Each full question will have a sub-question covering all the topics under a module.
10. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Books

Suggested Learning Resources:

Books

1. "Pattern Recognition and Machine Learning", C.M. Bishop, 2nd Edition, Springer, 2011.
2. Probabilistic machine learning by Kevin P Murphy
3. Pattern recognition by Duda and Hart
4. Machine Learning for Signal Processing: Data Science, Algorithms, and Computational Statistics, Max A. Little
5. Deep Learning By Ian Goodfellow, Yoshua Bengio, Aaron Courville Online book, 2017
6. Deep Learning with Python By J. Brownlee
7. Deep Learning Step by Step with Python: A Very Gentle Introduction to Deep Neural Networks for Practical Data Science By N. D. Lewis
8. "Machine Learning for Audio, Image and Video Analysis", F. Camastra, Vinciarelli, Springer, 2007. link http://www.dcs.gla.ac.uk/~vincia/textbook.pdf

Web links and Video Lectures (e-Resources):

https://www.mooc.org/

https://onlinecourses.nptel.ac.in/

Skill Development Activities Suggested

Mini project group wise on implementation of Machine learning algorithm using python

Course Outcomes

At the end of the course the student will be able to :

Sl. No.	Description	Blooms Level

CO1	Understand a very broad collection of machine learning algorithms and problems.	L2
CO2	To Demonstrate knowledge in the application/analysis of Machine Learning algorithms to solve various types of learning tasks	L2
CO3	Learn algorithmic topics of machine learning and mathematically deep enough to introduce the required theory	L2 L3
CO4	Carry out research/Investigation for a given Machine Learning Technique	L5

DSP System Design			
Course Code	**22LSP14**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	2:0:2	SEE Marks	50
Total Hours of Pedagogy	25 hours Theory + 10-12 slots for Skill Development Activities	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

- To explain the architecture and instruction set DSP processor
- To understand the linear mid rate quantization process

Module-1

Implementation considerations:Introduction,Data representation and arithmetic, Finite word length effects, Programming issues, Real time implementation considerations, Hardware interfacing, Experiments

Teaching-Learning Process	Chalk and Talk / Power Point Presentations.

Module-2

Architecture and Instruction Set of the C6x Processor: Introduction, TMS320C6x Architecture, Functional Units, Linear and Circular Addressing Modes, TMS320C6x Instruction Set, Interrupts, Multichannel Buffered Serial Ports, Memory Considerations, Fixed- and Floating-Point Format, Constraints

Teaching-Learning Process	Chalk and Talk / Power Point Presentations.

Module-3

Fixed point Digital signal processor : Introduction, TMS320C2000, TMS320C54X, TMS320C55X, TMS320C62X and TMS320C64X, **Floating point digital signal processo**r: Introduction, TMS320C3X,TMS320C67XX TMS320C6713 Digital signal processor, TMS3203X6416 Digital signal processor

Teaching-Learning Process	Chalk and Talk / Power Point Presentations.

Module-4

Introduction to Z transform, Discrete signals, FIR filters, FIR lattice structure, FIR implementation using Fourier series and window functions. Implementation using Matlab **IIR filters**: Introduction, IIR filter structures, bilinear transformation, implementation using Matlab

Teaching-Learning Process	Chalk and Talk / Power Point Presentations.

Module-5

Linear midrate quantization, µLawcompanding,DPCM,DeltaModulation and adaptive DPCM, DCT, Modified DCT and Transform coding in MPEG audio, Examples of signal quantization using TMS320CX713DSK,Matlab programs **Sub band and wavelet based coding** : sub band coding basics, sub band decomposition, sub band coding of signals, wavelet basics and families of wavelet multi resolution equations, Discrete wavelet transform, wavelet transform coding of signals,matlab programs.

Teaching-Learning Process	Chalk and Talk / Power Point Presentations.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks or one Skill Development Activity of 40 marks**

to attain the COs and POs

The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Books

1. 'Digital Signal Processors, architecture, Implementations and Applications Sen M Kuo,Woon-SengS.Gan Pearson prentice hall publishers-7th edition.
2. 'Digital Signal Processing and Application with C6713 and C6416 DSK', RulphChassaing, Donald ReayWiley-Interscience Publication.
3. Digital signal processing fundamentals and applications Li Tan,Jean Jiang Elsevier second edition
4. Digital signal processing Principles, algorithm and applications by John G proakis,Dimitris G manolokis Pearson fourth edition.
5. Digital signal processing by salivahanan,Avallavaraj,GnanapriyaTaTaMcGrawl-Hill 2007
6.Digital signal processing with Matlab programs Dr.sanjaysharma SK kataria&sons sixth edition

Web links and Video Lectures (e-Resources):

https://www.mooc.org/
https://onlinecourses.nptel.ac.in/

Skill Development Activities Suggested

- To simulate the signals and signal processing using DSP processor using CCS Studio of TMS320c6XXX series

Course Outcomes

At the end of the course the student will be able to :

Sl. No.	Description	Blooms Level
CO1	Able to understand and analyze the DSP processor architecture	L1 L2 L3
CO2	Able to analyze the fixed point and floating point DSP processor	L4
CO3	Able to understand and analyze digital filter systems	L2L4
CO4	Able to understand and analyze the digital modulation systems	L2 L4

Advanced Multivariate Systems and Filters Banks			
Course Code	**22LSP15**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	2:0:2	SEE Marks	50
Total Hours of Pedagogy	25 hours Theory + 10-12 slots for Skill Development Activities	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

- Describe the need of multi-rate systems and it applications.
- Understand the theory of multi-rate DSP, solve numerical problems and write algorithms.
- Understand theory of prediction and solution of normal equation

Module-1	
Fundamentals of Multirate Systems: Basic multi-rate operations, interconnection of building blocks, poly-phase representation, multistage implementation, applications of multi-rate systems, special filters and filter bank	
Teaching-Learning Process	Chalk and Talk / Power Point Presentations.

Module-2	
Maximally decimated filter banks: Errors created in the QMF bank, alias-free QMF system, power symmetric QMF banks, M-channel filter banks, poly-phase representation, perfect reconstruction systems, alias-free filter banks, tree structured filter banks, trans-multiplexers	
Teaching-Learning Process	Chalk and Talk / Power Point Presentations.

Module-3	
Para-unitary Perfect Reconstruction Filter Banks: Lossless transfer matrices, filter bank properties induced by para-unitariness, two channel Para-unitary lattices, M-channel FIR Para-unitary QMF banks, transform coding	
Teaching-Learning Process	Chalk and Talk / Power Point Presentations.

Module-4	
Linear Phase Perfect Reconstruction QMF Banks: Necessary conditions, lattice structures for linear phase FIR PR QMF banks, formal synthesis of linear phase FIR PR QMF lattice Cosine Modulated Filter Banks: Pseudo-QMF bank and its design, efficient poly-phase structures, properties of cosine matrices, cosine modulated perfect reconstruction systems	
Teaching-Learning Process	Chalk and Talk / Power Point Presentations.

Module-5	
Wavelet Transform: Short-time Fourier transform, Wavelet L2, L3 transform, discrete-time Ortho-normal wavelets, continuous time Ortho-normal wavelets	
Teaching-Learning Process	Chalk and Talk / Power Point Presentations.

Assessment Details (both CIE and SEE)

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Continuous Internal Evaluation:

1. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks or one Skill Development Activity of 40 marks** to attain the COs and POs

The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

3. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
4. The question paper will have ten full questions carrying equal marks.
5. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
6. Each full question will have a sub-question covering all the topics under a module.
7. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Books

1. P.P.Vaidyanathan, "Multirate Systems and Filter Banks", Pearson Education (Asia) Pte.Ltd, 2004.
2. Gilbert Strang and Truong Nguyen, "Wavelets and Filter Banks", Wellesley-Cambridge Press,1996.
3. N. J. Fliege, "Multirate Digital Signal Processing‖, John Wiley & Sons, USA,2000.
4. Vikram Gadre & Aditya Abhyankar "Multiresolution and Multirate Signal Processing: Introduction, Principles and Applications" McGraw Hill Education, First edition(2017).
5. Steven M. Kay "Modern Spectral Estimation" Pearson Education, First edition (2017)

Web links and Video Lectures (e-Resources):

https://www.mooc.org/

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Skill Development Activities Suggested

- To implement the filter bank and its spectrum using Matlab software

Course Outcomes

At the end of the course the student will be able to :

Sl. No.	Description	Blooms Level
CO1	Able to understand and implement the multirate systems	L2 L4
CO2	Able to understand and analyze decimated filter banks and reconstruction filter banks	L2 L4
CO3	Able to understand QMF banks, efficient poly – phase structures	L1 L2
CO4	Able to understand and analyze the STFT, CWT and DWT	L2 L4

Research Methodology and IPR			
Course Code	**22RMI16**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40 Hours	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

1. Discuss research methodology and the technique of defining a research problem
2. Explain the functions of the literature review in research, carrying out a literature search, developing theoretical and conceptual frameworks and writing a review.
3. Explain various research designs, sampling designs, measurement and scaling techniques and also different methods of data collections.
4. Explain several parametric tests of hypotheses, Chi-square test, art of interpretation and writing research reports
5. Discuss various forms of the intellectual property, its relevance and business impact in the changing global business environment and leading International Instruments concerning IPR

Module-1	
Teaching-Learning Process	Chalk and Talk / Power Point Presentations.

Module-2	
Teaching-Learning Process	Chalk and Talk / Power Point Presentations.

Module-3	
Teaching-Learning Process	Chalk and Talk / Power Point Presentations.

Module-4	
Teaching-Learning Process	Chalk and Talk / Power Point Presentations.

Module-5	
Teaching-Learning Process	Chalk and Talk / Power Point Presentations.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks or one Skill Development Activity of 40 marks**

to attain the COs and POs

The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

3. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
4. The question paper will have ten full questions carrying equal marks.
5. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
6. Each full question will have a sub-question covering all the topics under a module.
7. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Books

Textbooks:

1. Research Methodology: Methods and Techniques, C.R. Kothari, Gaurav Garg, New Age International,4th Edition, 2018.
2. Research Methodology a step-by-step guide for beginners. (For the topic Reviewing the literature under module 2), Ranjit Kumar, SAGE Publications,3rd Edition, 2011.
3. Study Material (For the topic Intellectual Property under module 5), Professional Programme Intellectual Property Rights, Law and Practice, The Institute of Company Secretaries of India, Statutory Body Under an Act of Parliament, September 2013.
4. Research Methods: the concise knowledge base, Trochim, Atomic Dog Publishing, 2005.
5. Conducting Research Literature Reviews: From the Internet to Paper, Fink A, Sage Publications, 2009.

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https://onlinecourses.nptel.ac.in/

Course outcome (Course Skill Set)
At the end of the course the student will be able to :

Sl. No.	Description	Blooms Level
CO1	Discuss research methodology and the technique of defining a research problem.	L1, L2
CO2	Explain the functions of the literature review in research, carrying out a literature search, developing theoretical and conceptual frameworks and writing a review.	L1, L2
CO3	Explain various research designs, sampling designs, measurement and scaling techniques and also different methods of data collections.	L1, L2
CO4	Explain several parametric tests of hypotheses, Chi-square test, art of interpretation and writing research reports.	L1, L2, L3
CO5	Discuss various forms of the intellectual property, its relevance and business impact in the changing global business environment and leading International Instruments concerning IPR.	L1, L2, L3, L4

22LSPL17			
Course Code	**Advanced Digital Signal Processing Lab**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	1:0:2:0	SEE Marks	50
Credits	02	Exam Hours	03

Course objectives:

- To understand the Matlab software for digital signal processing problems
- To learn the various programming skills to implement the digital signal processing algorithms

Sl.NO	Experiments

1	Generate various fundamental discrete time signals.
2	Basic operations on signals (Multiplication, Folding, Scaling).
3	Find out the DFT & IDFT of a given sequence without using inbuilt instructions.
4	Interpolation & decimation of a given sequence.
5	Generation of DTMF (Dual Tone Multiple Frequency) signals.
6	Estimate the PSD of a noisy signal using periodogram and modified periodogram.
7	Estimation Of PSD using different methods (Bartlett, Welch, Blackman-Tukey).
8	Design of Chebychev Type I,II Filters.
9	Cascade Digital IIR Filter Realization.
10	Parallel Realization of IIR filter.
11	Estimation of power spectrum using parametric methods (Yule-Walker & Burg).
12	Design of LPC filter using Levinson-Durbin algorithm.
13	Time-Frequency Analysis with the Continuous Wavelet Transform.
14	Signal Reconstruction from Continuous Wavelet Transform Coefficients.
	Demonstration Experiments (For CIE)
1	To implement the LPC filter using Matlab Simulink
2	To implement the Time-Frequency Analysis with the Continuous Wavelet Transform using Matlab Simulink
3	To implement the Signal Reconstruction from Continuous Wavelet Transform Coefficients using Matlab Simulink

Course outcomes (Course Skill Set):

At the end of the course the student will be able to:

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each course. The student has to secure not less than 40%of maximum marks in the semester-end examination(SEE). In total of CIE and SEE student has to secure 50% maximum marks of the course.

Continuous Internal Evaluation (CIE):

CIE marks for the practical course is **50 Marks**.

The split-up of CIE marks for record/ journal and test are in the ratio **60:40**.

- Each experiment to be evaluated for conduction with observation sheet and record write-up. Rubrics for the evaluation of the journal/write-up for hardware/software experiments designed by the faculty who is handling the laboratory session and is made known to students at the beginning of the practical session.
- Record should contain all the specified experiments in the syllabus and each experiment write-up will be evaluated for 10 marks.
- Total marks scored by the students are scaled downed to 30 marks (60% of maximum marks).
- Weightage to be given for neatness and submission of record/write-up on time.
- Department shall conduct 02 tests for 100 marks, the first test shall be conducted after the 8^{th} week of the semester and the second test shall be conducted after the 14^{th} week of the semester.
- In each test, test write-up, conduction of experiment, acceptable result, and procedural knowledge will carry a weightage of 60% and the rest 40% for viva-voce.
- The suitable rubrics can be designed to evaluate each student's performance and learning ability.
- The average of 02 tests is scaled down to **20 marks** (40% of the maximum marks).

The Sum of **scaled-down** marks scored in the report write-up/journal and average marks of two tests is the total CIE marks scored by the student.

Semester End Evaluation (SEE):

SEE marks for the practical course is 50 Marks.

SEE shall be conducted jointly by the two examiners of the same institute, examiners are appointed by the University.

All laboratory experiments are to be included for practical examination.

(Rubrics) Breakup of marks and the instructions printed on the cover page of the answer script to be strictly adhered to by the examiners. **OR** based on the course requirement evaluation rubrics shall be decided jointly by examiners.

Students can pick one question (experiment) from the questions lot prepared by the internal /external examiners jointly.

Evaluation of test write-up/ conduction procedure and result/viva will be conducted jointly by examiners.

General rubrics suggested for SEE are mentioned here, writeup-20%, Conduction procedure and result in 60%, Viva-voce 20% of maximum marks. SEE for practical shall be evaluated for 100 marks and scored marks shall be scaled down to 50 marks (however, based on course type, rubrics shall be decided by the examiners)

Change of experiment is allowed only once and 10% Marks allotted to the procedure part to be made zero.

The duration of SEE is 03 hours

Suggested Learning Resources:

www.matworks.com

Sl No.	Course Code	Course Title	National Coordinator
1	22AUD18		NPTEL

	/22AEC18	Real-Time Digital Signal Processing	
2	22AUD18 /22AEC18	Patent Law for Engineers and Scientists	NPTEL
3	22AUD18 /22AEC18	Advanced Engineering Mathematics	NPTEL
4	22AUD18 /22AEC18	Embedded System Design With ARM	NPTEL
5	22AUD18 /22AEC18	Digital Image Processing	NPTEL
6	22AUD18 /22AEC18	Computer Vision	
7	22AUD18 /22AEC18	Digital Speech Processing	NPTEL
8	22AUD18 /22AEC18	Image Signal Processing	NPTEL

Audit Courses /Ability Enhancement Courses Suggested by BOS (ONLINE courses):

Audit Courses: These are prerequisite courses suggested by the concerned Board of Studies. Ability Enhancement Courses will be suggested by the BoS if prerequisite courses are not required for the programs.

Ability Enhancement Courses:

- These courses are prescribed to help students to enhance their skills in fields connected to the field of specialization as well allied fields that leads to employable skills. Involving in learning such courses are impetus to lifelong learning.
- The courses under this category are online courses published in advance and approved by the concerned Board of Studies.
- Registration to Audit / Ability Enhancement Course shall be done in consultation with the mentor and is compulsory during the concerned semester.
- In case a candidate fails to appear for the proctored examination or fails to pass the selected online course, he/she can register and appear for the same course if offered during the next session or register for a new course offered during that session, in consultation with the mentor.

The Audit Ability Enhancement Course carries no credit and is not counted for vertical progression. However, a pass in such a course is mandatory for the award of the degree.

M.TECH IN SIGNAL PROCESSING (LSP)

Choice Based Credit System (CBCS) and Outcome Based Education (OBE)

(Effective from the academic year 2022-23)

Semester – 2

Digital Compression			
Course Code	**22LSP21**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	2:0:2	SEE Marks	50
Total Hours of Pedagogy	25 Hours of Teaching and 10 to 12 sessions of Skill Development Activities.	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

- Acquire contemporary knowledge in Data Compression and Coding.
- Equip with skills to analyze and evaluate different Data Compression and Coding methods

Module-1	
Introduction: Compression techniques, Modelling & coding, Distortion criteria, Differential Entropy, Rate Distortion Theory, Coding uniquely decodable codes, Prefix codes, Kraft McMillan Inequality. Quantization: Quantization problem, Uniform Quantizer, Adaptive Quantization, Non-uniform Quantization; Entropy coded Quantization, Vector Quantization, LBG algorithm, Tree structured VQ, Structured VQ.	
Teaching-Learning Process	Chalk and Talk / Power Point Presentations.

Module-2	
Differential Encoding: Basic algorithm, Prediction in DPCM, Adaptive DPCM, Delta Modulation, Speech coding–G.726, Image coding Transform Coding: Transforms–KLT,DCT,DST,DWHT; Quantization and coding of transform coefficients, Application Image compression–JPEG, Application to audio compression	
Teaching-Learning Process	Chalk and Talk / Power Point Presentations.

Module-3	
Sub-band Coding: Filters, Sub-band coding algorithm, Design of filter banks, Perfect reconstruction using two channel filter banks, M-band QMF filter banks, Poly-phase decomposition, Bit L1, L2 allocation, Speech coding–G.722, Audio coding–MPEG audio, Image compression.	
Teaching-Learning Process	Chalk and Talk / Power Point Presentations.

Module-4

Wavelet Based Compression: Wavelets, Multi resolution analysis & scalingfunction, Implementation using filters, Image compression–EZW, SPIHT, JPEG 2000.

Analysis/Synthesis Schemes: Speech compression–LPC – 10,CELP, MELP.

Video Compression: Motion compensation, Video signal representation, Algorithms for video conferencing & video phones–H.261, H.263, Asymmetric applications–MPEG 4, MPEG 7, Packet video

Teaching-Learning Process	Chalk and Talk / Power Point Presentations.

Module-5

Loss less Coding: Huffman coding, Adaptive Huffman coding, Golomb codes, Rice codes, Tunstall codes, Applications of Huffman coding, Arithmetic coding, Algorithm implementation, L1, L2 Applications of Arithmetic coding, Dictionary techniques–LZ77,LZ78, Applications of LZ78– JBIG, JBIG2, Predictive coding– Prediction with partial match, Burrows Wheeler Transform, Applications– CALIC, JPEG-LS.

Teaching-Learning Process	Chalk and Talk / Power Point Presentations.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

5. Three Unit Tests each of **20 Marks**
6. Two assignments each of **20 Marks** or **one Skill Development Activity of 40 marks** to attain the COs and POs

The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

11. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
12. The question paper will have ten full questions carrying equal marks.
13. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
14. Each full question will have a sub-question covering all the topics under a module.
15. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Books

1. **K.Sayood, "Introduction to Data Compression", Harcourt India Pvt. Ltd. & Morgan Kaufmann Publishers, 1996.**
2. **N.JayantandP.Noll, "Digital Coding of Waveforms: Principles and Applications to Speech and Video", Prentice Hall, USA, 1984.**
3. **D.Salomon, "Data Compression: The Complete Reference", Springer, 2000.**
4. **Z.LiandM.S.Drew, "Fundamentals of Multimedia", Pearson Education (Asia) Pvt.Ltd., 2004.**

Web links and Video Lectures (e-Resources):

https://www.mooc.org/ **https://onlinecourses.nptel.ac.in/**
Skill Development Activities Suggested • Mini project to compress the signals and image using various algorithms

Course Outcomes

At the end of the course the student will be able to :

Sl. No.	Description	Blooms Level
CO1	Able to understand the working principle of compression techniques	L1 L2
CO2	Able to understand and analyze the time domain and frequency domain transformation techniques of compression	L2 L4
CO3	Able to understand and analyze the image compression and video compression	L2 L4
CO4	Able to understand the wavelet based compression techniques	L1 L2

Image Processing & Machine Vision			
Course Code	**22LSP22**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:2:0	SEE Marks	50
Total Hours of Pedagogy	40 hours Theory + 10-12 Lab slots	Total Marks	100
Credits	04	Exam Hours	04

Course objectives:

- Describe the Digital Image fundamentals
- To implement the image enhancement algorithms
- To understand the computer vision techniques

MODULE-1

Introduction and Digital Image Fundamentals

Motivation & Perspective, Applications, Components of Image Processing System, Fundamentals Steps in Image Processing, Image Sampling and Quantization, Some basic relationships like Neighbors, Connectivity, Distance Measures between pixels

Teaching-Learning Process	Chalk and Talk / Power Point Presentations.

MODULE-2

Image Enhancement in the Spatial and Frequency Domain

Image enhancement by point processing, Image enhancement by neighbourhood processing, Basic Gray Level Transformations, Histogram Processing, Enhancement Using Arithmetic and Logic operations, Zooming, Basics of Spatial Filters, Smoothening and Sharpening Spatial Filters, Combining Spatial Enhancement Methods. Introduction to Fourier Transform and the frequency Domain, Smoothing and Sharpening Frequency Domain Filters, Homomorphic Filtering

Teaching-Learning Process	Chalk and Talk / Power Point Presentations.

MODULE-3

Image Restoration and Image Compression

Model of The Image Degradation / Restoration Process, Noise Models, Restoration in the presence of Noise Only Spatial Filtering, Periodic Noise Reduction by Frequency Domain Filtering, Linear Position-Invariant Degradations, Estimation of Degradation Function, Inverse filtering, Wiener filtering, Constrained Least Square Filtering, Geometric Mean Filter, Geometric Transformations. Data Redundancies, Image Compression models, Elements of Information Theory, Lossless and Lossy compression, Huffman Coding, Shanon-Fano Coding, Arithmetic Coding, Golomb Coding, LZW Coding, Run Length Coding, Loss less predictive Coding, Bit Plane Coding, Image compression standards.

Teaching-Learning Process	Chalk and Talk / Power Point Presentations.

MODULE-4

Image Segmentation and Morphological Image Processing

Discontinuity based segmentation, similarity based segmentation, Edge linking and boundary detection, 20% Threshold, Region based Segmentation Introduction to Morphology, Dilation, Erosion, Some basic Morphological Algorithms

Teaching-Learning Process	Chalk and Talk / Power Point Presentations.

MODULE 5

Object Representation and description and Computer Vision Techniques

Introduction to Morphology, Some basic Morphological Algorithms, Representation, Boundary Descriptors, Regional Descriptors, Chain Code, Structural Methods. Review of Computer Vision applications; Fuzzy-Neural algorithms for

computer vision applications	
Teaching-Learning Process	Chalk and Talk / Power Point Presentations.

PRACTICAL COMPONENT OF IPCC*(May cover all / major modules)*

Sl.NO	Experiments
1	**Write a program in Matlab to compute the histogram of an Image**
2	**Write a program in Matlab to compute the logic operations on image**
3	**Write a program in Matlab to find the edge of an image**
4	**Write a program in Matlab to compute the Huffman coding**
5	**Write a program in Matlab to compute the bit plane slicing**
6	**Write a program in Matlab to lossless predictive coding**
	Demo experiments for CIE
1	**Write a program in Matlab to implement the Fuzzy logic algorithm**
2	**Write a program in Matlab to implement the neural network algorithm**

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

CIE for the theory component of IPCC

4. Two Tests each of **20 Marks**
5. Two assignments each of **10 Marks/One Skill Development Activity of 20 marks**
6. Total Marks of two tests and two assignments/one Skill Development Activity added will be CIE for 60 marks, marks scored will be proportionally scaled down to **30 marks**.

CIE for the practical component of IPCC

- On completion of every experiment/program in the laboratory, the students shall be evaluated and marks shall be awarded on the same day. The **15 marks** are for conducting the experiment and preparation of the laboratory record, the other **05 marks shall be for the test** conducted at the end of the semester.
- The CIE marks awarded in the case of the Practical component shall be based on the continuous evaluation of the laboratory report. Each experiment report can be evaluated for 10 marks. Marks of all experiments' write-ups are added and scaled down to 15 marks.
- The laboratory test at the end /after completion of all the experimentsshall be conducted for 50 marks and scaled down to 05 marks**.**

Scaled-down marks of write-up evaluations and tests added will be CIE marks for the laboratory component of IPCC for **20 marks**.

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SEE for IPCC

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (duration 03 hours)

5. The question paper will be set for 100 marks and marks scored will be scaled down proportionately to 50 marks.
6. The question paper will have ten questions. Each question is set for 20 marks.
7. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
8. The students have to answer 5 full questions, selecting one full question from each module.

The theory portion of the IPCC shall be for both CIE and SEE, whereas the practical portion will have a CIE component only. Questions mentioned in the SEE paper shall include questions from the practical component).

- The minimum marks to be secured in CIE to appear for SEE shall be the 15 (50% of maximum marks-30) in the theory component and 10 (50% of maximum marks -20) in the practical component. The laboratory component of the IPCC shall be for CIE only. However, in SEE, the questions from the laboratory component shall be included**.** The maximum of 04/05 questions to be set from the practical component of IPCC, the total marks of all questions should not be more than the 20 marks.
- SEE will be conducted for 100 marks and students shall secure 40% of the maximum marks to qualify in the SEE. Marks secured will be scaled down to 50. (Student has to secure an aggregate of 50% of maximum marks of the course(CIE+SEE)

Suggested Learning Resources:

Books

1. Digital Image Processing Rafael C. Gonzalez Pearson Education3rd edition & Richard E. Woods
2. Computer Vision: A Modern David A. Forsyth, Prentice Hall Approach Jean Ponce
3. Fundamental of Digital Image Processing A.K. Jain PHI
4. Digital Image Processing W K Pratt

Web links and Video Lectures (e-Resources):

https://www.mooc.org/

https://onlinecourses.nptel.ac.in/

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

- **To do mini project in the field of Digital Image Processing and Machine vision**

Course Outcomes

At the end of the course the student will be able to :

Sl. No.	Description	Blooms Level
CO1	Able to understand the fundamentals of digital image	L2
CO2	Able to understand and analyze the image enhancement in the spatial and frequency domain	L2 L3
CO3	Able to analyze the image restoration and compression in spatial and frequency domain	L6
CO4	Able to understand and analyze image segmentation and morphological image processing in spatial and frequency domain	L2 L4
CO5	Able to analyze the computer vision techniques	L3

VLSI in Signal Processing			
Course Code	**22LSP231**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	2:0:2	SEE Marks	50
Total Hours of Pedagogy	25 Hours of Teaching and 10 to 12 sessions of Skill Development Activities.	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

- To explain the VLSI applications
- To understand the VLSI in signal processing

Module-1

Introduction To DSP Systems: Introduction; representation of DSP algorithms: Block Diagram, signal flow graph, data flow graph, dependence graph. Iteration Bound: Data flow graph representations, loop bound and iteration bound, longest path matrix algorithm, iteration bound of Multirate data flow graphs.

Teaching-Learning Process	Chalk and Talk / Power Point Presentations.

Module-2

Pipelining and Parallel Processing: Introduction, Pipelining of FIR Digital Filters, Parallel Processing. Pipelining and Parallel Processing for Low Power. Retiming: Introduction, Definition and Properties, Solving System of Inequalities, Retiming Techniques.

Teaching-Learning Process	Chalk and Talk / Power Point Presentations.

Module-3

Unfolding: Introduction an Algorithms for Unfolding, Properties of Unfolding, Critical Path, Unfolding and Retiming Application of Unfolding. Folding: Introduction to Folding Transformation, Register Minimization Techniques, Register Minimization in Folded Architectures, Folding in Multirate Systems.

Teaching-Learning Process	Chalk and Talk / Power Point Presentations.

Module-4

Systolic Architecture Design: Introduction, Systolic Array Design Methodology, FIR Systolic Arrays, Selection of Scheduling Vector, Matrix Multiplication and 2D Systolic Array Design, Systolic Design for Space Representations Containing Delays.

Teaching-Learning Process	Chalk and Talk / Power Point Presentations.

Module-5

Fast Convolution: Introduction, Cook, Toom Algorithm, Winograd Algorithm, Iterated Convolution, Cyclic Convolution, Design of Fast Convolution Algorithm by Inspection.

Teaching-Learning Process	Chalk and Talk / Power Point Presentations.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks or one Skill Development Activity of 40 marks**

to attain the COs and POs

The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

3. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
4. The question paper will have ten full questions carrying equal marks.
5. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
6. Each full question will have a sub-question covering all the topics under a module.
7. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Books

1. Keshab K. Parhi. VLSI Digital Signal Processing Systems, Wiley-Inter Sciences, 1999

2. Mohammed Ismail, Terri, Fiez, Analog VLSI Signal and Information Processing, McGraw Hill, 1994.

3. Kung. S.Y., H.J. While house T.Kailath, VLSI and Modern singal processing, Prentice Hall, 1985.

4. Jose E. France, YannisTsividls, Design of Analog Digital VLSI Circuits for Telecommunications and Signal Processing' Prentice Hall, 1994.

Web links and Video Lectures (e-Resources):

https://www.mooc.org/
https://onlinecourses.nptel.ac.in/

Skill Development Activities Suggested

- To visit telecommunication manufacturing companies

Course Outcomes

At the end of the course the student will be able to :

Sl. No.	Description	Blooms Level
CO1	Understand VLSI design methodology for signal processing systems.	L1 L2
CO2	Be familiar with VLSI algorithms and architectures for DSP.	L2 L4
CO3	Be able to implement basic architectures for DSP using CAD tools.	L4

Nano Electronics			
Course Code	**22LSP232**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	2:0:2	SEE Marks	50
Total Hours of Pedagogy	25 Hours of Teaching and 10 to 12 sessions of Skill Development Activities.	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

- To analyze the Moore's law
- To understand the spectroscopy techniques
- To understand the fabrication techniques

Module-1

Introduction: Overview of nanoscience and engineering. Development milestones in microfabrication and electronic industry. Moores' law and continued miniaturization, Classification of Nanostructures, Electronic properties of atoms and solids: Isolated atom, Bonding between atoms, Giant molecular solids, Free electron models and energy bands, crystalline solids, Periodicity of crystal lattices, Electronic conduction, effects of nanometer length scale, Fabrication methods: Top down processes, Bottom up processes methods for templating the growth of nanomaterials, ordering of nano systems

Teaching-Learning Process	Chalk and Talk / Power Point Presentations.

Module-2

Characterization: Classification, Microscopic techniques, Field ion microscopy, scanning probe techniques, diffraction techniques: bulk and surface diffraction techniques,

Spectroscopy techniques: photon, radiofrequency, electron, surface analysis and dept profiling: electron, mass, Ion beam, Reflectometry, Techniques for property measurement: mechanical, electron, magnetic, thermal properties

Teaching-Learning Process	Chalk and Talk / Power Point Presentations.

Module-3

Inorganic semiconductor nanostructures: overview of semiconductor physics. Quantum confinement in semiconductor nanostructures: quantum wells, quantum wires, quantum dots, super-lattices, band offsets, electronic density of states

Carbon Nanostructures: Carbon molecules, Carbon Clusters, Carbon Nanotubes, application of Carbon Nanotubes

Teaching-Learning Process	Chalk and Talk / Power Point Presentations.

Module-4

Fabrication techniques: requirements of ideal semiconductor, epitaxial growth of quantum wells, lithography and etching, cleaved-edge over growth, growth of vicinal substrates, strain induced dots and wires, electrostatically induced dots and wires, Quantum well width fluctuations, thermally annealed quantum wells, semiconductor nanocrystals, colloidal quantum dots, self-assembly techniques.

Physical processes: modulation doping, quantum hall effect, resonant tunnelling, charging effects, ballistic carrier transport, Inter band absorption, intra band absorption, Light emission processes, phonon bottleneck, quantum confined stark effect, nonlinear effects, coherence and dephasing, characterization of semiconductor nanostructures: optical electrical and structural

Teaching-Learning Process	Chalk and Talk / Power Point Presentations.

Module-5	
Methods of measuring properties: atomic, crystallography, microscopy, spectroscopy **Applications**: Injection lasers, quantum cascade lasers, single-photon sources, biological tagging, optical memories, coulomb blockade devices, photonic structures, QWIPs, NEMS, MEMS	
Teaching-Learning Process	Chalk and Talk / Power Point Presentations.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks or one Skill Development Activity of 40 marks**

to attain the COs and POs

The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

3. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
4. The question paper will have ten full questions carrying equal marks.
5. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
6. Each full question will have a sub-question covering all the topics under a module.
7. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Books

1. **'**Nanoscale Science and Technology**'**, Ed Robert Kelsall, Ian Hamley, Mark Geoghegan, John Wiley, 2007
2. **'**Introduction to Nanotechnology**'**, Charles P Poole, Jr, Frank J Owens, John Wiley, Copyright 2006, Reprint 2011.
3. **'**Hand Book of Nanoscience Engineering and Technology**'**, Ed William A Goddard III, Donald W Brenner, Sergey E. Lyshevski, Gerald J Iafrate, CRC Press, 2003

Web links and Video Lectures (e-Resources):

https://www.mooc.org/
https://onlinecourses.nptel.ac.in/

Skill Development Activities Suggested

- To visit nanotechnology laboratories

Course Outcomes

At the end of the course the student will be able to :

Sl. No.	Description	Blooms Level

CO1	Able to understand the Moore's law, bottom up process	L1 L2
CO2	Able to understand and analyze the microscopic and spectroscopy techniques	L2 L4
CO3	Able to understand the carbon nanostructures	L2
CO4	Able to understand and analyze the fabrication techniques	L2 L4
CO5	Able to understand the applications of nano electronics	L2

Deep learning in Signal Processing			
Course Code	**22LSP233**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	2:0:2	SEE Marks	50
Total Hours of Pedagogy	25 Hours of Teaching and 10 to 12 sessions of Skill Development Activities.	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

- To understand the foundations of linear algebra and Artificial Neural Networks
- To acquire the knowledge on Deep Learning Concepts
- To gain knowledge to apply optimization strategies

.

Module-1	
Introduction, Brief Review of concepts from linear Algebra,vector calculus, Types of errors, bias-variance trade-off, overfitting-underfitting, brief review of concepts from optimization, variants of gradient descent, momentum based methods	
Teaching-Learning Process	Chalk and Talk / Power Point Presentations.

Module-2	
Basic concepts of artificial neurons, single and multi layer perceptrons, perceptron learning algorithm, its convergence proof, different activation functions, softmax cross entropy loss function, Basic concepts of Linear and Logistic Regression.	
Teaching-Learning Process	Chalk and Talk / Power Point Presentations.

Module-3	
ConvNets: Basic concepts of Convolutional Neural Networks starting from filtering. Convolution and pooling operation and arithmetic's of these. ConvNet Architectures: Discussions on famous convnet architectures - AlexNet, ZFNet, VGG, C3D, GoogLeNet, ResNet, MobileNet-v1, MobileNet-v2, EfficientNet, GhostNet. Discussion on regularization, Dropout, Batchnorm etc	
Teaching-Learning Process	Chalk and Talk / Power Point Presentations.

Module-4	
Discussion on detection, segmentation problem definition, challenges, Evaluation, Datasets and Localization by regression. Discussion on detection as classification, region proposals, RCNN and YOLO architectures, fully convolutional segmentations, Mask-RCNNs.	
Teaching-Learning Process	Chalk and Talk / Power Point Presentations.

Module 5	
Deep generative models – Auto encoders, Boltzmann machines, adversarial networks Applications in computer vision and speech recognition	
Teaching-Learning Process	Chalk and Talk / Power Point Presentations.

Assessment Details (both CIE and SEE)

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Continuous Internal Evaluation:

1. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks** or **one Skill Development Activity of 40 marks**

to attain the COs and POs

The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

3. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
4. The question paper will have ten full questions carrying equal marks.
5. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
6. Each full question will have a sub-question covering all the topics under a module.
7. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Books

1. Linear Algebra and its applications by Gilbert strang ,4th edition
2. Deep Learning: An MIT Press Book By Ian Goodfellow and Yoshua Bengio and Aaron Courville
3. Neural Networks and Learning Machines, Simon Haykin, 3rd Edition, Pearson Prentice Hall..

Reference text Books

1. Duda, R.O., Hart, P.E., and Stork, D.G. Pattern Classi cation. Wiley-Interscience. 2nd Edition. 2001. ■
2. Theodoridis, S. and Koutroumbas, K. Pattern Recognition. Edition 4. Academic Press, 2008. ■ Russell, S. and Norvig, N. Arti cial Intelligence: A Modern Approach. Prentice Hall Series in Arti cial Intelligence. 2003.
3. Bishop, C. M. Neural Networks for Pattern Recognition. Oxford University Press. 1995.
4. Hastie, T., Tibshirani, R. and Friedman, J. The Elements of Statistical Learning. Springer. 2001.
5. Koller, D. and Friedman, N. Probabilistic Graphical Models. MIT Press. 2009.

Web links and Video Lectures (e-Resources):

https://www.mooc.org/

https://onlinecourses.nptel.ac.in/

- http://cs231n.stanford.edu/ CS231n: Convolutional Neural Networks for Visual Recognition
- http://web.stanford.edu/class/cs224n/ CS224n: Natural Language Processing with Deep Learning
- http://rll.berkeley.edu/deeprlcourse/ CS 294: Deep Reinforcement Learning
- http://distill.pub/ Very nice explanations of some DL concepts

Skill Development Activities Suggested

- To perform experiments on basics of Deep learning and Machine learning algorithms

Course Outcomes

At the end of the course the student will be able to :

Sl. No.	Description	Blooms Level
CO1	Able to understand the basics of Linear Algebra , fundamentals of Deep learning and optimization techniques.	L2 L3
CO2	Able to understand the concepts of Artificial Neural networks and its implementation using regression models	L2 L3
CO3	Able to understand convolution neural networks and implement the various architectures of convolution neural networks	L2 L3
CO4	Able to understand and analyze the detection and segmentation problems	L1 L2 L4

Reconfigurable Computing			
Course Code	**22LSP234**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	2:0:2	SEE Marks	50
Total Hours of Pedagogy	25 Hours of Teaching and 10 to 12 sessions of Skill Development Activities.	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

- To explain reconfigurable computing system
- To understand High Level Synthesis for Reconfigurable Devices

Module-1	
Introduction: History, Reconfigurable vs Processor based system, RC Architecture. **Reconfigurable Logic Devices**: Field Programmable Gate Array, Coarse Grained Reconfigurable Arrays. **Reconfigurable Computing System**: Parallel Processing on Reconfigurable Computers, A survey of Reconfigurable Computing System	
Teaching-Learning Process	Chalk and Talk / Power Point Presentations.

Module-2	
Languages and Compilation: Design Cycle, Languages, HDL, High Level Compilation, Low level Design flow, Debugging Reconfigurable Computing Applications	
Teaching-Learning Process	Chalk and Talk / Power Point Presentations.

Module-3	
Implementation: Integration, FPGA Design flow, Logic Synthesis. **High Level Synthesis for Reconfigurable Devices:** Modelling, Temporal Partitioning Algorithms	
Teaching-Learning Process	Chalk and Talk / Power Point Presentations.

Module-4	
Partial Reconfiguration Design: Partial Reconfiguration Design, Bitstream Manipulation with JBits, The modular Design flow, The Early Access Design Flow, Creating Partially Reconfigurable Designs, Partial Reconfiguration using Hansel-C Designs, Platform Design	
Teaching-Learning Process	Chalk and Talk / Power Point Presentations.

Module-5	
Signal Processing Applications: Reconfigurable computing for DSP, DSP application building blocks, Examples: Beamforming, Software Radio, Image and video processing, Local Neighbourhood functions, Convolution **System on a Programmable Chip**: Introduction to SoPC, Adaptive Multiprocessing on Chip	
Teaching-Learning Process	Chalk and Talk / Power Point Presentations.

Assessment Details (both CIE and SEE)

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Continuous Internal Evaluation:

1. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks or one Skill Development Activity of 40 marks**

to attain the COs and POs

The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

3. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
4. The question paper will have ten full questions carrying equal marks.
5. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
6. Each full question will have a sub-question covering all the topics under a module.
7. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Books

1. **'**Reconfigurable Computing: Accelerating Computation with Field-Programmable Gate Arrays**'**, M. Gokhale and P. Graham, Springer, ISBN: 978-0-387-26105-8, 2005.
2. **'**Introduction to Reconfigurable Computing: Architectures, Algorithms and Applications**'**, C. Bobda, Springer, ISBN: 978-1-4020-6088-5, 2007.
3. **'**Practical FPGA Programming in C**'**, D. Pellerin and S. Thibault, Prentice-Hall, 2005.
4. **'**FPGA Based System Design**'**, W. Wolf, Prentice-Hall, 2004.
5. **'**Rapid System Prototyping with FPGAs: Accelerating the Design Process**'**, R. Cofer and B. Harding, Newnes, 2005.

Web links and Video Lectures (e-Resources):

https://www.mooc.org/

https://onlinecourses.nptel.ac.in/

Skill Development Activities Suggested

- To perform experiments on signal processing applications using Matlab / Labview software

Course Outcomes

At the end of the course the student will be able to :

Sl. No.	Description	Blooms Level
CO1	Able to understand the reconfigurable systems	L2
CO2	Able to understand and analyze the partial reconfigurable design	L2 L4
CO3	Able to analyze the signal processing techniques	L4

Artificial Neural Network and Applications			
Course Code	**22LSP235**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	2:0:2	SEE Marks	50
Total Hours of Pedagogy	25 Hours of Teaching and 10 to 12 sessions of Skill Development Activities.	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

- To describe the artificial neural model
- To explain the supervised learning and support vector machine

Module-1

Introduction:
Biological Neuron- Artificial Neural Model- Types of activation functions-
Architecture:
Feed forward and Feedback, Convex Sets, Convex Hull and Linear Separability, Non-Linear Separable Problem. XOR Problem, Multilayer Networks.
Learning:
Learning Algorithms, Error correction and Gradient Descent Rules, Learning objective of TLNs, Perceptron Learning Algorithm, Perceptron Convergence Theorem.

Teaching-Learning Process	Chalk and Talk / Power Point Presentations.

Module-2

Supervised Learning:
Perceptron learning and Non Separable sets, a.-Least Mean Square Learning, MSE Error surface, Steepest Descent Search, JL-LMS approximate to gradient descent, Application of LMS to Noise Cancelling, Multi-layered Network Architecture, Back propagation Learning Algorithm, Practical consideration of BP algorithm.

Teaching-Learning Process	Chalk and Talk / Power Point Presentations.

Module-3

Support Vector Machines and Radial Basis Function:
Learning from Examples, Statistical Learning Theory, Support Vector Machines, SVM application to Image Classification, Radial Basis Function Regularization theory, Generalized RBF Networks, Learning in RBFNs, RBF application to face recognition.

Teaching-Learning Process	Chalk and Talk / Power Point Presentations.

Module-4

Attractor Neural Networks:
Associative Learning Attractor Associative Memory, Linear Associative memory, Hopfield Network, application of Hopfield Network, Brain State in a Box neural Network, Simulated Annealing, Boltzmann Machine, Bidirectional Associative Memory.

Teaching-Learning Process	Chalk and Talk / Power Point Presentations.

Module-5

Self-organization Feature Map:
Maximal Eigenvector Filtering, Extracting Principal Components, Generalized Learning Laws, Vector Quantization, Self organization Feature Maps, Application of SOM, Growing Neural Gas.

Teaching-Learning Process	Chalk and Talk / Power Point Presentations.

Assessment Details (both CIE and SEE)

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Continuous Internal Evaluation:

1. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks** or **one Skill Development Activity of 40 marks**

to attain the COs and POs

The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

3. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
4. The question paper will have ten full questions carrying equal marks.
5. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
6. Each full question will have a sub-question covering all the topics under a module.
7. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Books

1. Neural Networks A Classroom Approach- Satish Kumar, McGraw Hill Education (India) Pvt. Ltd, Second Edition.
2. Introduction to Artificial Neural Systems-J.M. Zurada, Jaico Publications 1994.
3. Artificial Neural Networks-B. Yegnanarayana, PHI, New Delhi 1998.

Web links and Video Lectures (e-Resources):

https://www.mooc.org/
https://onlinecourses.nptel.ac.in/

Skill Development Activities Suggested

- Perform experiments on implementing Neural network applications using Matlab software

Course Outcomes

At the end of the course the student will be able to :

Sl. No.	Description	Blooms Level
CO1	Able to understand the biological neuron and artificial neural network model	L1 L2
CO2	Able to understand and analyze the support vector machine and radial basis function	L2 L4
CO3	Able to understand the supervised learning algorithms	L2
CO4	Able to understand and analyze the associative memory, brain state in box neural network	L2 L4

Cryptography and Network Security			
Course Code	**22LSP241**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	2:0:2	SEE Marks	50
Total Hours of Pedagogy	25 Hours of Teaching and 10 to 12 sessions of Skill Development Activities.	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

- To explain the crypto systems
- To describe IP security

Module-1

Foundations: Terminology, Steganography, substitution ciphers and transpositions ciphers, Simple XOR, One-Time Pads, Computer Algorithms (Text 2: Chapter 1: Section 1.1 to 1.6).

SYMMETRIC CIPHERS: Traditional Block Cipher structure, Data encryption standard (DES), The AES Cipher. (Text 1: Chapter 2: Section2.1, 2.2, Chapter 4).

Teaching-Learning Process	Chalk and Talk / Power Point Presentations.

Module-2

Introduction to modular arithmetic, Prime Numbers, Fermat's and Euler's theorem, primality testing, Chinese Remainder theorem, discrete logarithm.

Principles of Public-Key Cryptosystems, The RSA algorithm, Diffie - Hellman Key Exchange, Elliptic Curve Arithmetic, Elliptic Curve Cryptography

Teaching-Learning Process	Chalk and Talk / Power Point Presentations.

Module-3

Pseudo-Random-Sequence Generators and Stream Ciphers: Linear Congruential Generators, Linear Feedback Shift Registers, Design and analysis of stream ciphers, Stream ciphers using LFSRs, A5, Hughes XPD/KPD, Nanoteq, Rambutan, Additive generators, Gifford, Algorithm M, PKZIP

Teaching-Learning Process	Chalk and Talk / Power Point Presentations.

Module-4

One-Way Hash Functions: Background, Snefru, N-Hash, MD4, MD5, Secure Hash Algorithm [SHA], One way hash functions using symmetric block algorithms, Using public key algorithms, Choosing a one-way hash functions, Message Authentication Codes. Digital Signature Algorithm, Discrete Logarithm Signature Scheme

Teaching-Learning Process	Chalk and Talk / Power Point Presentations.

Module-5

E-mail Security: Pretty Good Privacy-S/MIME

IP Security: IP Security Overview, IP Security Policy, Encapsulation Security Payload (ESP), Combining security Associations.

Web Security: Web Security Considerations, SSL

Teaching-Learning Process	Chalk and Talk / Power Point Presentations.

Assessment Details (both CIE and SEE)

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4. The question paper will have ten full questions carrying equal marks.
5. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
6. Each full question will have a sub-question covering all the topics under a module.
7. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Books

1. **'**Cryptography and Network Security Principles and Practice**'**, William Stallings, Pearson Education Inc., ISBN: 978-93325-1877-3, 6th Edition, 2014
2. **'**Applied Cryptography Protocols, Algorithms, and Source code in C**'**, Bruce Schneier, Wiley Publications ISBN: 9971-51348-X, 2nd Edition
3. **'**Cryptography and Network Security**'**, Behrouz A. Forouzan, TMH, 2007
4. **'**Cryptography and Network Security**'**, Atul Kahate, TMH, 2003

Web links and Video Lectures (e-Resources):

https://www.mooc.org/

https://onlinecourses.nptel.ac.in/

Skill Development Activities Suggested

- To do mini project group wise on any cryptography applications

Course Outcomes

At the end of the course the student will be able to :

Sl. No.	Description	Blooms Level
CO1	Able to understand the fundamentals of data encryption standard	L2
CO2	Able to understand and analyze the E – mail security and web security	L2 L4
CO3	Able to understand and analyze the pseudo – random sequence generation and stream ciphers	L2 L4

Cyber Security			
Course Code	**22LSP242**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	2:0:2	SEE Marks	50
Total Hours of Pedagogy	25 Hours of Teaching and 10 to 12 sessions of Skill Development Activities.	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

- To understand the cyber crime and laws and computer forensics
- To explain the phishing and identity theft

Module-1

Introduction to Cybercrime and Laws

Introduction, Cybercrime: Definition and Origins of the word, Cybercrime and information Security, Who are Cybercriminals? Classifications of Cybercrimes. How Criminals Plan Them – Introduction, How Criminals Plan the Attacks, Cybercafé and Cybercrimes, Botnets, Attack Vector, The Indian IT ACT 2000 and amendments.

Teaching-Learning Process	Chalk and Talk / Power Point Presentations.

Module-2

Tools and Methods used in Cybercrime

Introduction, Proxy Server and Anonymizers, Password Cracking, Key loggers and Spyware, Virus and Warms, Trojan and backdoors, Steganography, DOS and DDOS attack, SQLinjection, Buffer Overflow.

Teaching-Learning Process	Chalk and Talk / Power Point Presentations.

Module-3

Phishing and Identity Theft

Introduction, Phishing – Methods of Phishing, Phishing Techniques, Phishing Toolkits andSpy Phishing. Identity Theft – PII, Types of Identity Theft, Techniques of ID Theft. Digital Forensics Science, Need for Computer Cyber forensics and Digital Evidence, Digital Forensics Life Cycle.

Teaching-Learning Process	Chalk and Talk / Power Point Presentations.

Module-4

Understanding Computer Forensics: Introduction, Historical Background of Cyber forensics, Digital Forensics Science, The Need for Computer Forensics, Cyber forensics and Digital Evidence, Forensics Analysis of E- Mail, Digital Forensics Life Cycle, Chain of Custody Concept, Network Forensics, Approaching a Computer Forensics Investigation, Setting up a Computer Forensics Laboratory: UnderstandingtheRequirements,ComputerForensicsandSteganography,RelevanceoftheOSI7Layer Model to Computer Forensics, Forensics and Social Networking Sites: The Security/Privacy Threats, ComputerForensicsfromCompliancePerspective,ChallengesinComputerForensics,SpecialToolsandTechniques, Forensics Auditing, Anti forensics.

Teaching-Learning Process	Chalk and Talk / Power Point Presentations.

Module-5

Introduction to Security Policies andCyber Laws:NeedforAnInformationSecurityPolicy,Information SecurityStandards–Iso,IntroducingVariousSecurityPoliciesandTheirReviewProcess,IntroductiontoIndianCyberLaw,ObjectiveandScopeof the IT Act,2000,IntellectualPropertyIssues,Overview of Intellectual -Property - Related Legislation in India, Patent, Copyright, Law Related to Semiconductor Layout and Design,Software License

Teaching-Learning Process	Chalk and Talk / Power Point Presentations.

Assessment Details (both CIE and SEE)

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Continuous Internal Evaluation:

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to attain the COs and POs

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Semester End Examination:

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5. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
6. Each full question will have a sub-question covering all the topics under a module.
7. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Books

1. Anti-Hacker Tool Kit (Indian Edition) by Mike Shema, Publication McGraw Hill.
2. Cyber Security Understanding Cyber Crimes, Computer Forensics and Legal Perspectives byNina Godbole and SunitBelpure, Publication Wiley.
3. Introduction to information securityand cyberlaws Surya Prakash Tripathi,RitendraGoyal, PraveenKumarShukla Dreamtech Press 2015
4. Marjie T. Britz - Computer Forensics and Cyber Crime: An Introduction - Pearson
5. Chwan-Hwa (John) Wu,J. David Irwin - Introduction to Computer Networks and Cyber securityCRCPress
6. Bill Nelson, Amelia Phillips, Christopher Steuart - Guide to Computer Forensics and InvestigationsCengage Learning

Web links and Video Lectures (e-Resources):

https://www.mooc.org/

https://onlinecourses.nptel.ac.in/

Skill Development Activities Suggested

- To do mini project group wise on any cyber security applications

Course Outcomes

At the end of the course the student will be able to :

Sl. No.	Description	Blooms Level
CO1	Able to understand the cyber crime and cyber laws	L2
CO2	Able to understand and analyze the tools and methods used in cyber crime	L2 L4
CO3	Able to understand and analyze the phishing and identity, computer forensics	L2 L4

Micro Electro Mechanical Systems			
Course Code	**22LSP243**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	2:0:2	SEE Marks	50
Total Hours of Pedagogy	25 Hours of Teaching and 10 to 12 sessions of Skill Development Activities.	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

- To explain MEMS
- To understand the working principles of micro systems
- To analyze the scaling laws in miniaturization

Module-1

Overview of MEMS and Microsystems: MEMS and Micro system, Typical MEMS and Microsystems Products, Evolution of Microfabrication, Microsystems and Microelectronics, Multidisciplinary Nature of Microsystems, Miniaturization. Applications and Markets.

Teaching-Learning Process	Chalk and Talk / Power Point Presentations.

Module-2

Working Principles of Microsystems: Introduction, Micro sensors, Micro actuation, MEMS with Micro actuators, Micro accelerometers, Micro fluidics.

Engineering Science for Microsystems Design and Fabrication: Introduction, Atomic Structure of Matters, Ions and Ionization, Molecular Theory of Matter and Inter-molecular Forces, Doping of Semiconductors, The Diffusion Process, Plasma Physics, Electrochemistry

Teaching-Learning Process	Chalk and Talk / Power Point Presentations.

Module-3

Engineering Mechanics for Microsystems Design: Introduction, Static Bending of Thin Plates, Mechanical Vibration, Thermo mechanics, Fracture Mechanics, Thin Film Mechanics, Overview on Finite Element Stress Analysis.

Teaching-Learning Process	Chalk and Talk / Power Point Presentations.

Module-4

Scaling Laws in Miniaturization:

Introduction, Scaling in Geometry, Scaling in Rigid-Body Dynamics, Scaling in Electrostatic Forces, Scaling of Electromagnetic Forces, Scaling in Electricity, Scaling in Fluid Mechanics, Scaling in Heat Transfer.

Teaching-Learning Process	Chalk and Talk / Power Point Presentations.

Module-5

Overview of Micro-manufacturing: Introduction, Bulk Micro-manufacturing, Surface Micromachining, The LIGA Process, Summary on Micro manufacturing.

Microsystem Design: Introduction, Design Considerations, Process Design, Mechanical Design, Using Finite Element Method.

Teaching-Learning Process	Chalk and Talk / Power Point Presentations.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks or one Skill Development Activity of 40 marks**

to attain the COs and POs

The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

3. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
4. The question paper will have ten full questions carrying equal marks.
5. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
6. Each full question will have a sub-question covering all the topics under a module.
7. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Books

1. **'**MEMS and Micro systems: Design, Manufacture and Nanoscale Engineering**'**, Tai-Ran Hsu, John Wiley & Sons, ISBN: 978-0470-08301-7, 2nd Edition, 2008
2. **'**Micro and Nano Fabrication: Tools and Processes**'**, Hans H. Gatzen, Volker Saile, Jurg Leuthold, Springer, 2015
3. **'**Micro Electro Mechanical Systems (MEMS)**'**, Dilip Kumar Bhattacharya, Brajesh Kumar Kaushik, Cengage Learning.

Web links and Video Lectures (e-Resources):

https://www.mooc.org/

https://onlinecourses.nptel.ac.in/

Skill Development Activities Suggested

- To set up MEMS model

Course Outcomes

At the end of the course the student will be able to :

Sl. No.	Description	Blooms Level
CO1	Able to understand the MEMS and Micro systems	L1 L2
CO2	Able to understand and analyze the mechanics for Microsystems design	L1 L2 L3
CO3	Able to analyze the scaling laws in miniaturization	L4

Detection and Estimation			
Course Code	**22LSP244**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	2:0:2	SEE Marks	50
Total Hours of Pedagogy	25 Hours of Teaching and 10 to 12 sessions of Skill Development Activities.	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

- To explain the detection estimation theory
- To understand the linear estimation

Module-1	
Classical Detection and Estimation Theory: Introduction, simple binary hypothesis tests, M Hypotheses, estimation theory, composite hypotheses, general Gaussian problem, performance bounds and approximations	
Teaching-Learning Process	Chalk and Talk / Power Point Presentations.

Module-2	
Representations of Random Processes: Introduction, orthogonal representations, random process characterization, homogenous integral equations and Eigen functions, periodic processes, spectral decomposition, vector random processes	
Teaching-Learning Process	Chalk and Talk / Power Point Presentations.

Module-3	
Detection of Signals & Estimation of Signal Parameters: Introduction, detection and estimation in white Gaussian noise, detection and estimation in nonwhite Gaussian noise, signals with unwanted parameters, multiple channels and multiple parameter estimation	
Teaching-Learning Process	Chalk and Talk / Power Point Presentations.

Module-4	
Estimation of Continuous Waveforms: Introduction, derivation of estimator equations, lower bound on the mean-square estimation error, multidimensional waveform estimation, non-random waveform estimation	
Teaching-Learning Process	Chalk and Talk / Power Point Presentations.

Module-5	
Linear Estimation: Properties of optimum processors, realizable linear filters, Kalman-Bucy filters, fundamental role of optimum linear filters	
Teaching-Learning Process	Chalk and Talk / Power Point Presentations.

Assessment Details (both CIE and SEE)

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Continuous Internal Evaluation:

1. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks or one Skill Development Activity of 40 marks**

to attain the COs and POs

The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

3. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
4. The question paper will have ten full questions carrying equal marks.
5. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
6. Each full question will have a sub-question covering all the topics under a module.
7. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Books

1. **'**Detection, Estimation, and Modulation Theory**'**, Part I, Harry L. Van Trees, John Wiley & Sons, USA, 2001.
2. **'**Random Signals: Detection, Estimation and Data Analysis**'**, K Sam Shanmugam, Arthur M Breipohl, John Wiley & Sons, 1998.
3. **'**Introduction to Statistical Signal Processing with Applications**'**, M.D. Srinath, P.K. Rajasekaran and R. Viswanathan, Pearson Education (Asia) Pvt. Ltd. /Prentice Hall of India, 2003.
4. **'**Fundamentals of Statistical Signal Processing,**'** Volume I: **'**Estimation Theory**'**, Steven M. Kay, Prentice Hall, USA, 1998.
5. **'**Fundamentals of Statistical Signal Processing**'**, Volume II: **'**Detection Theory,**'** Steven M. Kay, Prentice Hall, USA, 1998.

Web links and Video Lectures (e-Resources):

https://www.mooc.org/

https://onlinecourses.nptel.ac.in/

Skill Development Activities Suggested

- Perform experiment on various detection and estimation algorithms

Course Outcomes

At the end of the course the student will be able to :

Sl. No.	Description	Blooms Level
CO1	Able to understand and analyze the classical detection and estimation theory	L1 L2 L4
CO2	Able to understand the estimation of continuous waveforms	L1L2
CO3	Able to understand linear estimation	L1 L2

Error Control Coding			
Course Code	**22LSP245**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	2:0:2	SEE Marks	50
Total Hours of Pedagogy	25 Hours of Teaching and 10 to 12 sessions of Skill Development Activities.	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

- To understand the Galois fields construction
- To solve the problems linear block codes, BCH codes, cyclic codes, convolution codes

Module-1

Information theory: Introduction, Entropy, Source coding theorem, discrete memoryless channel, Mutual Information, Channel Capacity Channel coding theorem

Introduction to algebra: Groups, Fields, binary field arithmetic, Construction of Galois Fields GF (2^m) and its properties, (Only statements of theorems without proof) Computation using Galois field GF (2^m) arithmetic, Vector spaces and Matrices

Teaching-Learning Process	Chalk and Talk / Power Point Presentations.

Module-2

Linear block codes: Generator and parity check matrices, Encoding circuits, Syndrome and error detection, Minimum distance considerations, Error detecting and error correcting capabilities, Standard array and syndrome decoding, Single Parity Check Codes (SPC), Repetition codes, Self dual codes, Hamming codes, Reed-Muller codes. Product codes and Interleaved codes

Teaching-Learning Process	Chalk and Talk / Power Point Presentations.

Module-3

Cyclic codes: Introduction, Generator and parity check polynomials, Encoding of cyclic codes, Syndrome computing and error detection, Decoding of cyclic codes, Error trapping Decoding, Cyclic hamming codes, Shortened cyclic codes

Teaching-Learning Process	Chalk and Talk / Power Point Presentations.

Module-4

BCH codes: Binary primitive BCH codes, Decoding procedures, Implementation of Galois field arithmetic. Primitive BCH codes over GF (q), **Reed -Solomon codes**

Majority Logic decodable codes: One -step majority logic decoding, Multiple-step majority logic

Teaching-Learning Process	Chalk and Talk / Power Point Presentations.

Module-5

Convolution codes: Encoding of convolutional codes: Systematic and Non systematic Convolutional Codes, Feed forward encoder inverse, A catastrophic encoder, Structural properties of convolutional codes: state diagram, state table, state transition table, tree diagram, trellis diagram. Viterbi algorithm, Sequential decoding: Log Likelihood Metric for Sequential Decoding

Teaching-Learning Process	Chalk and Talk / Power Point Presentations.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks or one Skill Development Activity of 40 marks**

to attain the COs and POs

The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

3. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
4. The question paper will have ten full questions carrying equal marks.
5. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
6. Each full question will have a sub-question covering all the topics under a module.
7. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Books

Textbooks:

1. **'**Digital Communication systems**'**, Simon Haykin, Wiley India Private. Ltd, ISBN 978-81-265-4231-4, First edition, 2014
2. **'**Error control coding**'**, Shu Lin and Daniel J. Costello. Jr, Pearson, Prentice Hall, 2nd edition, 2004
3. **'**Theory and practice of error control codes**'**, Blahut. R. E, Addison Wesley, 1984
4. **'**Introduction to Error control coding**'**, Salvatore Gravano, Oxford University Press, 2007
5. **'**Digital Communications - Fundamentals and Applications**'**, Bernard Sklar, Pearson Education (Asia) Pvt. Ltd., 2nd Edition, 2001

Web links and Video Lectures (e-Resources):

https://www.mooc.org/

https://onlinecourses.nptel.ac.in/

Skill Development Activities Suggested

- Perform experiments to implement linear block codes, BCH codes, Cyclic codes and convolutional codes usin Matlab software

Course Outcomes

At the end of the course the student will be able to :

Sl. No.	Description	Blooms Level
CO1	Able to understand and solve the problems of algebra	L1 L2 L4
CO2	Able to understand and solving problems of linear block codes and cyclic codes	L1 L2 L3
CO3	Able to understand and analyze the BCH and convolution codes	L2 L4

MINI PROJECT WITH SEMINAR			
Course Code	**22LSP25**	CIE Marks	100
Teaching Hours/Week (L:P:SDA)	(0:4:2)	SEE Marks	-
Total Hours of Pedagogy	30 hours Practical+10 Hours SDA	Total Marks	100
Credits	03	Exam Hours	-

Course Learning objectives: This course will enable students to:

- To support independent learning and innovative attitude.
- To guide to select and utilize adequate information from varied resources upholding ethics.
- To guide to organize the work in the appropriate manner and present information (acknowledging thesources) clearly.
- To develop interactive, communication, organisation, time management, and presentation skills.
- To impart flexibility and adaptability.
- To inspire independent and team working.
- To expand intellectual capacity, credibility, judgement, intuition.
- To adhere to punctuality, setting and meeting deadlines.
- To instil responsibilities to oneself and others.
- To train students to present the topic of project work in a seminar without any fear, face audienceconfidently, enhance communication skill, involve in group discussion to present and exchange ideas.

Mini Project With Seminar: This may be hands-on practice, survey report, data collection and analysis, coding, mobile app development, field visit and report preparation, modelling of system, simulation, analysing and authenticating, case studies, etc. Each student of the project batch shall involve in carrying out the project work jointly in constant consultation with internal guide, co-guide, and external guide and prepare the project report as per the norms avoiding plagiarism.

Course outcomes: At the end of the course the student will be able to:

1. Present the mini-project and be able to defend it.
2. Make links across different areas of knowledge and to generate, develop and evaluate ideas andinformation so as to apply these skills to the project task.
3. Habituated to critical thinking and use problem solving skills.
4. Communicate effectively and to present ideas clearly and coherently in both the written and oral forms.5.Work in a team to achieve common goal.
6. Learn on their own, reflect on their learning and take appropriate actions to improve it.

Continuous Internal Evaluation

CIE marks shall be awarded by a committee comprising of HoD as Chairman, Guide/co-guide, if any, and a senior faculty of the department. Students can present the seminar based on the completed mini-project. Participation in the seminar by all postgraduate students of the program shall be mandatory.

The CIE marks awarded for Mini-Project work and Seminar shall be based on the evaluation of Mini Project work and Report, Presentation skill and performance in Question and Answer session in the ratio **50:25:25**. Mini-Project with Seminar shall be considered as a head of passing and shall be considered for vertical progression as well as for the award of degree. Those, who do not take-up/complete the Mini Project and Seminar shall be declared as fail in that course and have to complete the same during the subsequent semester.

There is no SEE for this course. **RBT Level: L3, L4, L5, L6**

Image Processing Laboratory			
Course Code	**22LSPL26**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	1:2:0	SEE Marks	50
Credits	02	Exam Hours	03

Course objectives:

- To understand the Matlab commands to compose code for complex algorithm
- To implement Image processing algorithms

Sl.NO	Experiments
1	Study the effects of a) Boolean operations on binary images b) Quantization of gray level images
2	Study the effects of Contrast enhancement using a) Histogram equalization b) Histogram stretching.
3	Using connected component labelling algorithms, express Pixel neighbourhood relationships in terms of a graph
4	Create a binary image from image by replacing all values above a determined threshold level using a) global thresholding b) adaptive thresholding technique
5	Transform an image given using Spatial Transformation
6	Study how to compute forward 2D FFT and a) Find the log magnitude & phase and the inverse 2D FFT of an image. b) Compute the forward 2D FFT of the filter kernel. c) Design a Laplacian High Pass Filter d) Study the Two Dimensional Filter Design using filter design functions
7	Determine the suitability of homo – morphic filtering using a low pass filter for image enhancement to fix non- uniform of illumination
8	Implement inverse, Wiener, Regular, and Lucy-Richardson for image restoration. And formulate how noise information in an image can be used to restore a degraded image.
9	Study different methods of edge detection for use on noisy images, specifically, a) Motion blur b) Gaussian noise c) Filtered Gaussian noise via averaging.
10	Write an algorithm for recognizing of circles and triangles.
	Demonstration Experiments (For CIE) if any
11	**Write a program in Matlab to implement the Fuzzy logic algorithm**
12	**Write a program in Matlab to implement the neural network algorithm**

Course outcomes (Course Skill Set):
At the end of the course the student will be able to:

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each course. The student has to secure not less than 40%of maximum marks in the semester-end examination(SEE). In total of CIE and SEE student has to secure 50% maximum marks of the course.

Continuous Internal Evaluation (CIE):

CIE marks for the practical course is **50 Marks**.

The split-up of CIE marks for record/ journal and test are in the ratio **60:40**.

- Each experiment to be evaluated for conduction with observation sheet and record write-up. Rubrics for the evaluation of the journal/write-up for hardware/software experiments designed by the faculty who is handling the laboratory session and is made known to students at the beginning of the practical session.
- Record should contain all the specified experiments in the syllabus and each experiment write-up will be evaluated for 10 marks.
- Total marks scored by the students are scaled downed to 30 marks (60% of maximum marks).
- Weightage to be given for neatness and submission of record/write-up on time.
- Department shall conduct 02 tests for 100 marks, the first test shall be conducted after the 8^{th} week of the semester and the second test shall be conducted after the 14^{th} week of the semester.
- In each test, test write-up, conduction of experiment, acceptable result, and procedural knowledge will carry a weightage of 60% and the rest 40% for viva-voce.
- The suitable rubrics can be designed to evaluate each student's performance and learning ability.
- The average of 02 tests is scaled down to **20 marks** (40% of the maximum marks).

The Sum of **scaled-down** marks scored in the report write-up/journal and average marks of two tests is the total CIE marks scored by the student.

Semester End Evaluation (SEE):

SEE marks for the practical course is 50 Marks.

SEE shall be conducted jointly by the two examiners of the same institute, examiners are appointed by the University.

All laboratory experiments are to be included for practical examination.
(Rubrics) Breakup of marks and the instructions printed on the cover page of the answer script to be strictly adhered to by the examiners. **OR** based on the course requirement evaluation rubrics shall be decided jointly by examiners.
Students can pick one question (experiment) from the questions lot prepared by the internal /external examiners jointly.
Evaluation of test write-up/ conduction procedure and result/viva will be conducted jointly by examiners.
General rubrics suggested for SEE are mentioned here, writeup-20%, Conduction procedure and result in -60%, Viva-voce 20% of maximum marks. SEE for practical shall be evaluated for 100 marks and scored marks shall be scaled down to 50 marks (however, based on course type, rubrics shall be decided by the examiners)

Change of experiment is allowed only once and 10% Marks allotted to the procedure part to be made zero. The duration of SEE is 03 hours
Suggested Learning Resources: • www.mathworks.com

Sl No.	Course Code	Course Title	National Coordinator
1	22AUD27	Programming, Data Structures And Algorithms Using Python	NPTEL
2	22AUD27	Principles of Signal Estimation for MIMO/ OFDM Wireless Communication	NPTEL
3	22AUD27	Fundamentals Of Artificial Intelligence	NPTEL
4	22AUD27	Cryptography And Network Security	NPTEL
5	22AUD27	Introduction To Internet Of Things	NPTEL
6	22AUD27	Introduction to Machine Learning	NPTEL
7	22AUD27	Fundamentals of micro and nanofabrication	NPTEL
8	22AUD27	Introduction to Biomedical Imaging Systems	NPTEL

Audit Courses /Ability Enhancement Courses Suggested by BOS (ONLINE courses):

Audit Courses: These are prerequisite courses suggested by the concerned Board of Studies. Ability Enhancement Courses will be suggested by the BoS if prerequisite courses are not required for the programs.

Ability Enhancement Courses:

- These courses are prescribed to help students to enhance their skills in in fields connected to the field of specialization as well allied fields that leads to employable skills. Involving in learning such courses are impetus to lifelong learning.
- The courses under this category are online courses published in advance and approved by the concerned Board of Studies.
- Registration to Audit /Ability Enhancement Course shall be done in consultation with the mentor and is compulsory during the concerned semester.
- In case a candidate fails to appear for the proctored examination or fails to pass the selected online course, he/she can register and appear for the same course if offered during the next session or register for a new course offered during that session, in consultation with the mentor.

The Audit Ability Enhancement Course carries no credit and is not counted for vertical progression. However, a pass in such a course is mandatory for the award of the degree.

M.TECH IN SIGNAL PROCESSING (LSP)

Choice Based Credit System (CBCS) and Outcome Based Education (OBE)

(Effective from the academic year 2022-23)

Semester – 3

Adaptive Signal Processing			
Course Code	**22LSP31**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:2	SEE Marks	50
Total Hours of Pedagogy	40 Hours Theory+10 Hours SDA	Total Marks	100
Credits	04	Exam Hours	03

Course Learning objectives:

- To understand the adaptive filter concepts
- To analyze the LMS algorithms and its applications

Module-1	
Adaptive systems: Definitions and characteristics - applications - properties-examples - adaptive linear combiner input signal and weight vectors - performance function-gradient and minimum mean square error - introduction to filtering-smoothing and prediction - linear optimum filtering – orthogonality - Wiener **–** Hopf equation performance Surface.	
Teaching-Learning Process	Chalk and Talk / Power Point Presentations.
Module-2	
Searching performance surface-stability and rate of convergence: learning curve-gradient search - Newton's method - method of steepest descent - comparison - gradient estimation - performance penalty - variance - excess MSE and time constants **–** mis adjustments.	
Teaching-Learning Process	Chalk and Talk / Power Point Presentations.
Module-3	
LMS algorithm convergence of weight vector: LMS/Newton algorithm - properties - sequential regression algorithm **–** adaptive recursive filters - random-search algorithms - lattice structure - adaptive filters with orthogonal signals	
Teaching-Learning Process	Chalk and Talk / Power Point Presentations.
Module-4	
Applications-adaptive modelling: Multipath communication channel, geophysical exploration, FIR digital filter synthesis.	
Teaching-Learning Process	Chalk and Talk / Power Point Presentations.
Module-5	
Applications: inverse adaptive modelling, deconvolution and equalization, General Description of Inverse Modeling, Adaptive Equalization of Telephone Channels, Adapting Poles and Zeros for IIR Digital Filter Synthesis.	
Teaching-Learning Process	Chalk and Talk / Power Point Presentations.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

7. Three Unit Tests each of **20 Marks**
8. Two assignments each of **20 Marks or one Skill Development Activity of 40 marks** to attain the COs and POs

The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

16. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
17. The question paper will have ten full questions carrying equal marks.
18. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
19. Each full question will have a sub-question covering all the topics under a module.
20. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Books

1. **'**Adaptive Signal Processing**'**, Bernard Widrow and Samuel D Stearns, Pearson Education, 2005.
2. **'**Theory and Design of Adaptive Filters**'**, John R Treichler, C Richard Johnson, Michael G Larimore, Prentice-Hall of India, 2002
3. **'**Adaptive Signal Processing-Theory and Application**'**, S Thomas Alexander, Springer-Verlag.
4. **'**Statistical and Adaptive Signal Processing**'**, D. G. Manolakis, V. K. Ingle and S. M. Kogar, McGraw Hill International Edition, 2000.
5. **'**Adaptive Filter Theory**'**, Simon Haykin, Pearson Education, 2003.

Web links and Video Lectures (e-Resources):

https://www.mooc.org/
https://onlinecourses.nptel.ac.in/

Skill Development Activities Suggested

- **Mini project in the area of adaptive signal processing using modern tools like MATLAB, Python, scilab**

Course Outcomes

At the end of the course the student will be able to :

Sl. No.	Description	Blooms Level
CO1	Able to understand the adaptive systems, wiener – Hopf equation	L1 L2
CO2	Able to understand the LMS algorithm convergence, lattice structures	L2
CO3	Able to understand and analyze the applications of applications of adaptive modeling	L2 L4
CO4	Able to understand the inverse adaptive filtering, deconvolution algorithms and equalization	L1 L2

Array Signal Processing			
Course Code	**22LSP321**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40 hours Theory	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

- To understand the spatial signals and sensor arrays
- To design the array sensors system

Module-1

Spatial Signals: Signals in space and time, Spatial Frequency vs Temporal Frequency, Review of Co-ordinate Systems, Maxwell's Equation, Wave Equation. Solution to Wave equation in Cartesian Co-ordinate system –Wave number vector, Slowness vector.

Teaching-Learning Process	Chalk and Talk / Power Point Presentations.

Module-2

Wave number-Frequency Space Spatial Sampling: Spatial Sampling Theorem-Nyquist Criteria, Aliasing in Spatial frequency domain, Spatial sampling of multidimensional signals.

Teaching-Learning Process	Chalk and Talk / Power Point Presentations.

Module-3

Sensor Arrays: Linear Arrays, Planar Arrays, Frequency – Wave number Response and Beam pattern, Array manifold vector, Conventional Beam former, Narrowband beam former.

Teaching-Learning Process	Chalk and Talk / Power Point Presentations.

Module-4

Uniform Linear Arrays: Beam pattern in θ, u and ψ -space, Uniformly Weighted Linear Arrays.

Beam Pattern Parameters: Half Power Beam Width, Distance to First Null, Location of side lobes and Rate of Decrease, Grating Lobes, Array Steering.

Teaching-Learning Process	Chalk and Talk / Power Point Presentations.

Module-5

Array Design Methods: Visible region, Duality between Time -Domain and Space -Domain Signal Processing, Schelkunoff's Zero Placement Method, Fourier Series Method with windowing, Woodward -Lawson Frequency-Sampling Design.

Non parametric method -Beam forming, Delay and sum Method, Capons Method.

Teaching-Learning Process	Chalk and Talk / Power Point Presentations.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks or one Skill Development Activity of 40 marks**

to attain the COs and POs

The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

3. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
4. The question paper will have ten full questions carrying equal marks.
5. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
6. Each full question will have a sub-question covering all the topics under a module.
7. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Books

1. **'**Optimum Array Processing Part IV of Detection, Estimation, and Modulation Theory**'**, Harry L. Van Trees, John Wiley & Sons, ISBN: 9780471093909, 2002.
2. **'**Array Signal Processing: Concepts and Techniques**'**, Don H. Johnson, Dan E. Dugeon, Prentice Hall Signal Processing Series, 1st Edition, ISBN-13: 978-0130485137.
3. **'**Spectral Analysis of Signals**'**, Petre Stoica and Randolph L. Moses, Prentice Hall, ISBN: 0-13-113956-8, 2005.
4. **'**Electromagnetic Waves and Antennas**'**, Sophocles J. Orfanidis, ECE Department, Rutgers University, 94 Brett Road Piscataway, NJ 88548058. http://www.ece.rutgers.edu/~orfanidi/ewa/

Web links and Video Lectures (e-Resources):

https://www.mooc.org/
https://onlinecourses.nptel.ac.in/

Skill Development Activities Suggested :

Implement array processing algorithms using any suitable software

Course Outcomes

At the end of the course the student will be able to :

Sl. No.	Description	Blooms Level
CO1	Able to understand the spatial signals, spatial frequency vs temporal frequency	L2
CO2	Able to understand and implement the sensor arrays, linear arrays planar arrays	L2 L3
CO3	Able to understand the design array methods	L2

Medical Imaging			
Course Code	**22LSP322**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40 hours Theory	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

- To explain the X – ray diagnostics methods
- To understand the various imaging the systems

Module-1

Generation and Detection of X-Rays: X-Ray generation and X-Ray generators, Filters, Beam Restrictors and Grids, Screens, X-Ray Detectors. **X-Ray Diagnostic Methods**: Conventional X-Ray Radiography, Fluoroscopy, Angiography, Mammography, Xeroradiography, Image Subtraction.

X-Ray Image Characteristics: Spatial Resolution, Image Noise, Image contrast.

Biological Effects of Ionizing Radiation: Determination of biological effects, Short term and Long term effects.

Teaching-Learning Process	Chalk and Talk / Power Point Presentations.

Module-2

X-Ray Tomography: Conventional Tomography, Computed Tomography - Projection function, Algorithms for Image Reconstruction, CT number, Image Artifacts.

Digital Radiography: Digital Subtraction Angiography (DSA), Dual Energy Subtraction, K-Edge subtraction, 3-D Reconstruction.

Recent Developments: Dynamic Spatial Reconstructor (DSR), Imatron or Fastrac Electron Beam CT.

Teaching-Learning Process	Chalk and Talk / Power Point Presentations.

Module-3

Generation and Detection of Ultrasound: Piezoelectric effect, Ultrasonic Transducers, Transducer Beam Characteristics, Axial and Lateral resolution, Focusing and Arrays.

Ultrasonic Diagnostic Methods: Pulse Echo systems - A mode, B mode, M mode and C mode, Transmission Methods, Doppler methods, Duplex Imaging. **Biological Effects of Ultrasound**: Acoustic phenomena at high intensity levels, Ultrasound Bio effects.

Teaching-Learning Process	Chalk and Talk / Power Point Presentations.

Module-4

Generation and Detection of Nuclear Emission: Nuclear Sources, Radionuclide Generators, Nuclear Radiation Detectors, Collimators.

Diagnostic methods using Radiation Detector Probes: Thyroid Function test, Renal function test, Blood volume measurement.

New Radio Nuclide Imaging methods: Longitudinal Section Tomography, SPECT and PET

Characteristics of Radionuclide Images: Spatial Resolution, Image contrast, Image Noise.

Teaching-Learning Process	Chalk and Talk / Power Point Presentations.

Module-5	
Generation and Detection of NMR signal: The NMR Coil/Probe, The transmitter and the Receiver, Data acquisition. **Magnetic Resonance Imaging methods**: Spin Echo Imaging, Gradient Echo Imaging, Blood flow Imaging. **Characteristics of MRI images**: Spatial Resolution, Image Contrast, Imaging Safety.	
Teaching-Learning Process	Chalk and Talk / Power Point Presentations.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks or one Skill Development Activity of 40 marks**

to attain the COs and POs

The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

3. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
4. The question paper will have ten full questions carrying equal marks.
5. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
6. Each full question will have a sub-question covering all the topics under a module.
7. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Books

1. **'**Principles of Medical Imaging**'**, Kirk Shung, Michael B Smith, Benjamin M W Tsui, Academic Press, 2012.
2. **'**Fundamentals of Medical Imaging**'**, Zhong Hicho and Manbir Singh, John Wiley, 1993.
3. **'**Nuclear Medicine Introductory Text**'**, Peter Josefell & Edwards Sydney, William Blackwell Scientific Publishers, London.

Web links and Video Lectures (e-Resources):

https://www.mooc.org/
https://onlinecourses.nptel.ac.in/

Skill Development Activities Suggested

To visit multispeciality hospital for practical knowledge

Course Outcomes

At the end of the course the student will be able to :

Sl. No.	Description	Blooms Level
CO1	Describe the fundamentals of x-ray radiography and computed tomography, and analyze thesystem requirements.	L1 L2
CO2	Explain principles of ultrasound imaging and diagnostic methods and analyze the systemrequirements.	L2 L4
CO3	Discuss the fundamentals of radionuclide imaging, MRI, thermal imaging and analyze thesystem requirements.	L3
CO4	Describe the concepts of image Guided Intervention and image guided surgery.	L1 L2
CO5	Design and develop prototype of simple medical imaging system.	L6

Business Intelligence and its Applications			
Course Code	**22LSP323**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40 hours Theory	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

- To explain the business intelligence steps
- To analyze the growth development and information technology applications

Module-1	
Development Steps, BI Definitions, BI Decision Support Initiatives, Development Approaches, Parallel Development Tracks, BI Project Team Structure, Business Justification, Business Divers, Business Analysis Issues, Cost – Benefit Analysis, Risk Assessment, Business Case Assessment Activities, Roles Involved In These Activities, Risks of Not Performing Step, Hardware, Middleware, DBMS Platform, Non-Technical Infrastructure Evaluation	
Teaching-Learning Process	Chalk and Talk / Power Point Presentations.

Module-2	
Managing The BI Project, Defining And Planning The BI Project, Project Planning Activities, Roles And Risks Involved In These Activities, General Business Requirement, Project Specific Requirements, Interviewing Process.	
Teaching-Learning Process	Chalk and Talk / Power Point Presentations.

Module-3	
Differences in Database Design Philosophies, Logical Database Design, Physical Database Design, Activities, Roles And Risks Involved In These Activities, Incremental Rollout, Security Management, Database Backup And Recovery	
Teaching-Learning Process	Chalk and Talk / Power Point Presentations.

Module-4	
Growth Management, Application Release Concept, Post Implementation Reviews, Release Evaluation Activities, The Information Asset and Data Valuation, Actionable Knowledge – ROI, BI Applications, The Intelligence Dashboard.	
Teaching-Learning Process	Chalk and Talk / Power Point Presentations.

Module-5	
Business View of Information technology Applications: Business Enterprise excellence, Key purpose of using IT, Type of digital data, basics of enterprise reporting, BI road ahead.	
Teaching-Learning Process	Chalk and Talk / Power Point Presentations.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks or one Skill Development Activity of 40 marks**

to attain the COs and POs

The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

3. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
4. The question paper will have ten full questions carrying equal marks.
5. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
6. Each full question will have a sub-question covering all the topics under a module.
7. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Books

1. **'**Business Intelligence Roadmap: The Complete Project Lifecycle for Decision Support Applications**'**, Larissa T Moss and Shaku Atre, Addison Wesley Information Technology Series, 2003.
2. **'**Fundamentals of Business Analytics**'**, R N Prasad, Seema Acharya, Wiley India, 2011.
3. **'**Business Intelligence: The Savvy Manager's Guide**'**, David Loshin, Publisher: Morgan Kaufmann, ISBN 1-55860-196-4.
4. **'**Delivering Business Intelligence with Microsoft SQL Server 2005**'**, Brian Larson, McGraw Hill, 2006.
5. **'**Foundations of SQL Server 2008**'**, Lynn Langit, Business Intelligence **–** Apress, ISBN13: 978-14302-3324-4, 2011.

Web links and Video Lectures (e-Resources):

https://www.mooc.org/
https://onlinecourses.nptel.ac.in/

Skill Development Activities Suggested

To learn SQL and implement various DBMS algorithms

Course Outcomes

At the end of the course the student will be able to :

Sl. No.	Description	Blooms Level
CO1	Able to understand the business intelligence development approaches	L2
CO2	Able to understand and analyze growth management, application release concept , intelligence dashboard	L2 L4
CO3	Able to understand the business view of information technology applications	L2

<table>
<tr><th colspan="4">Multimedia Systems and Applications</th></tr>
<tr><td>Course Code</td><td>22LSP324</td><td>CIE Marks</td><td>50</td></tr>
<tr><td>Teaching Hours/Week (L:P:SDA)</td><td>3:0:0</td><td>SEE Marks</td><td>50</td></tr>
<tr><td>Total Hours of Pedagogy</td><td>40 hours Theory</td><td>Total Marks</td><td>100</td></tr>
<tr><td>Credits</td><td>03</td><td>Exam Hours</td><td>03</td></tr>
<tr><td colspan="4">Course Learning objectives:
To explain the multimedia information representation
To describe the multimedia communication standards and across networks</td></tr>
<tr><td colspan="4">Module-1</td></tr>
<tr><td colspan="4">Multimedia Communications: Introduction, Multimedia information representation, multimedia networks, multimedia applications, Application and networking terminology.
Information Representation: Introduction, Text, Images.</td></tr>
<tr><td>Teaching-Learning Process</td><td colspan="3">Chalk and Talk / Power Point Presentations.</td></tr>
<tr><td colspan="4">Module-2</td></tr>
<tr><td colspan="4">Information Representation: Audio and Video.
Distributed multimedia systems: Introduction, main features of a DMS, Resource management of DMS, Networking, and Multimedia Operating Systems.</td></tr>
<tr><td>Teaching-Learning Process</td><td colspan="3">Chalk and Talk / Power Point Presentations.</td></tr>
<tr><td colspan="4">Module-3</td></tr>
<tr><td colspan="4">Multimedia Processing in Communication: Introduction, Perceptual coding of digital Audio signals, Transform Audio Coders, Audio Sub band Coders.</td></tr>
<tr><td>Teaching-Learning Process</td><td colspan="3">Chalk and Talk / Power Point Presentations.</td></tr>
<tr><td colspan="4">Module-4</td></tr>
<tr><td colspan="4">Multimedia Communication Standards: Introduction, MPEG approach to multimedia standardization, MPEG-1, MPEG-2, Overview of MPEG-4.</td></tr>
<tr><td>Teaching-Learning Process</td><td colspan="3">Chalk and Talk / Power Point Presentations.</td></tr>
<tr><td colspan="4">Module-5</td></tr>
<tr><td colspan="4">Multimedia Communication Across Networks: Packet audio/video in the network environment, Video transport across generic networks, Multimedia Transport across ATM Networks.</td></tr>
<tr><td>Teaching-Learning Process</td><td colspan="3">Chalk and Talk / Power Point Presentations.</td></tr>
</table>

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks or one Skill Development Activity of 40 marks**

to attain the COs and POs

The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

3. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
4. The question paper will have ten full questions carrying equal marks.
5. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from

Suggested Learning Resources:

Books

1. Fred Halsall, "Multimedia Communications", Pearson education, 2001, ISBN - 9788131709948.

2. K. R. Rao, Zoran S. Bojkovic, Dragorad A. Milovanovic, "Multimedia Communication Systems", Pearson education, 2004. ISBN -9788120321458.

3. Raif steinmetz, Klara Nahrstedt, "Multimedia: Computing, Communication and Applications", Pearson education, 2002, ISBN -9788177584417

Web links and Video Lectures (e-Resources):

https://www.mooc.org/
https://onlinecourses.nptel.ac.in/

Skill Development Activities Suggested

Implement various multimedia algorithms like JPEG MPEG using Matlab software

At the end of the course the student will be able to :

Sl. No.	Description	Blooms Level
CO1	Able to understand the multimedia networks, information representation	L2
CO2	Able to understand and analyze the distributed multimedia systems	L2 L3
CO3	Able to understand and analyze the multimedia communication standards	L2 L4
CO4	Able to understand the multimedia communication across the networks	L1 L2

Internet of Things (IOT)			
Course Code	**22LSP325**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40 hours Theory	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

- Define IOT and its architecture
- To understand the engineering IoT networks

Module-1

What is IoT ?

Genesis, Digitization, Impact, Connected Roadways, Buildings, Challenges

IoT Network Architecture and Design

Drivers behind new network Architectures, Comparing IoT Architectures, M2M architecture, IoT world forum standard, IoT Reference Model, Simplified IoT Architecture.

Teaching-Learning Process	Chalk and Talk / Power Point Presentations.

Module-2

IoT Network Architecture and Design

Core IoT Functional Stack, Layer1 (Sensors and Actuators), Layer 2 (Communications Sublayer), Access network sublayer, Gateways and backhaul sublayer, Network transport sublayer, IoT Network management.

Layer 3 (Applications and Analytics) **–** Analytics vs Control, Data vs Network Analytics, IoT Data Management and Compute Stack

Teaching-Learning Process	Chalk and Talk / Power Point Presentations.

Module-3

Engineering IoT Networks

Things in IoT **–** Sensors, Actuators, MEMS and smart objects. Sensor networks, WSN, Communication protocols for WSN Communications Criteria, Range, Frequency bands, power consumption,Topology, Constrained Devices, Constrained Node Networks IoT Access Technologies, IEEE 802.15.4 Competitive Technologies **–** Overview only of IEEE 802.15.4g, 4e, IEEE 1901.2a Standard Alliances **–** LTE Cat 0, LTE-M, NB-IoT

Teaching-Learning Process	Chalk and Talk / Power Point Presentations.

Module-4

Engineering IoT Networks

IP as IoT network layer, Key Advantages, Adoption, Optimization, Constrained Nodes, Constrained Networks, IP versions, Optimizing IP for IoT. Application Protocols for IoT **–** Transport Layer, Application Transport layer, Background only of SCADA, Generic web based protocols, IoT Application Layer

Data and Analytics for IoT **–** Introduction, Structured and Unstructured data, IoT Data Analytics overview and Challenges.

Teaching-Learning Process	Chalk and Talk / Power Point Presentations.

Module-5	
IoT in Industry (Three Use cases) IoT Strategy for Connected manufacturing, Architecture for Connected Factory Utilities – Power utility, IT/OT divide, Grid blocks reference model, Reference Architecture, Primary substation grid block and automation. Smart and Connected cities –Strategy, Smart city network Architecture, Street layer, city layer, Data center layer, services layer, Smart city security architecture, Smart street lighting.	
Teaching-Learning Process	Chalk and Talk / Power Point Presentations.

Assessment Details (both CIE and SEE)

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Continuous Internal Evaluation:

1. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks or one Skill Development Activity of 40 marks** to attain the COs and POs

The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

3. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
4. The question paper will have ten full questions carrying equal marks.
5. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
6. Each full question will have a sub-question covering all the topics under a module.
7. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Books

1. **'**CISCO, IoT Fundamentals **–** Networking Technologies, Protocols, Use Cases for IoT**'**, David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Robert Barton, Jerome Henry, Pearson Education, ISBN: 978-9386873743, First edition, 2017
2. **'**Internet of Things **–** A Hands on Approach**'**, Arshdeep Bahga and Vijay Madisetti, Orient Blackswan Private Limited - New Delhi, First edition, 2015

Web links and Video Lectures (e-Resources):

https://www.mooc.org/
https://onlinecourses.nptel.ac.in/

Skill Development Activities Suggested

To implement various IOT protocols

Course Outcomes

At the end of the course the student will be able to :

Sl. No.	Description	Blooms Level
CO1	Able to understand the IOT network architecture and design	L2
CO2	Able to understand and analyze WSN protocols, IEEE standard protocols, LTE	L2 L4
CO3	Able to analyze the engineering IOT networks	L4
CO4	Able to understand and analyze IOT in industry	L2

Biomedical Signal Processing			
Course Code	**22LSP331**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40 hours Theory	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

- To understand the biomedical signals acquisition and its analysis
- To analyze the various mathematical tools used in biomedical signal analysis

Module-1	
Introduction-Genesis and significance of bio electric potentials, ECG, EEG, EMG and their monitoring and measurement, Spectral analysis.	
Teaching-Learning Process	Chalk and Talk / Power Point Presentations.
Module-2	
Filtering- Digital and Analog filtering, Correlation and Estimation techniques, AR / ARMA models	
Teaching-Learning Process	Chalk and Talk / Power Point Presentations.
Module-3	
ECG-Pre-processing, Measurements of amplitude and time intervals, Classification, QRS detection, ST segment analysis, Base line wander removal, waveform recognition, morphological studies and rhythm analysis, automated diagnosis based on decision theory ECT compression, Evoked potential estimation.	
Teaching-Learning Process	Chalk and Talk / Power Point Presentations.
Module-4	
EEG: Evoked responses, Epilepsy detection, Spike detection, Hjorth parameters, averaging techniques, removal of Artifacts by averaging and adaptive algorithms, pattern recognition of alpha, beta, theta and delta waves in EEG waves, sleep stages.	
Teaching-Learning Process	Chalk and Talk / Power Point Presentations.
Module-5	
EMG-Wave pattern studies, bio feedback, Zero crossings, Integrated EMG. Time frequency methods and Wavelets in Biomedical Signal Processing.	
Teaching-Learning Process	Chalk and Talk / Power Point Presentations.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks or one Skill Development Activity of 40 marks**

to attain the COs and POs

The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

3. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
4. The question paper will have ten full questions carrying equal marks.
5. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
6. Each full question will have a sub-question covering all the topics under a module.
7. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Books

1. Biomedical Digital Signal Processing', Willis J Tompkins, Prentice Hall of India, 1996.
2. Rangaraj M. Rangayyan, "Biomedical Signal Analysis" , John Wiley & Sons, Inc, reprint 2000,
3. 'Biomedical Signal Processing (in IV parts)', R E Challis and RI Kitney, Medical and Biological Engg. and current computing, 1990-91.
4. Special issue on 'Biological Signal Processing', Proc. IEEE 1972.
5. 'Biomedical Signal Processing', Arnon Cohen, Volumes I & II, CRC Press.
6. 'Time frequency and Wavelets in Biomedical Signal Processing', Metin Akay, IEEE Press, 1999. Current Published literature.

Web links and Video Lectures (e-Resources):

https://www.mooc.org/
https://onlinecourses.nptel.ac.in/

Skill Development Activities Suggested

Design and implement the hardware circuit to acquire the various Bio – Medical signals
Design and implement using the software to process the various Bio – Medical signals

Course Outcomes

At the end of the course the student will be able to :

Sl. No.	Description	Blooms Level
CO1	Explain the significance of bio electric potentials	L1 L2
CO2	Discuss the AR/ARMA models for power spectral estimation	L2 L4
CO3	Implement the QRS detection, ST segment analysis, evoked potential estimation	L3 L4
CO4	Analyze the EEG pattern recognition, epilepsy detection, Hjorth parameters,	L$

Speech and Audio Processing			
Course Code	**22LSP332**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40 hours Theory	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

- Familiarize the basic mechanism of speech production and get an overview of articulatory and acoustic Phonetics.
- Learn the basic concepts of methods for speech analysis and parametric representation of speech.
- Acquire knowledge about various methods used for speech and audio coding.
- Get an overall picture about various applications of speech and audio processing.

Module-1

Digital Models for the Speech Signal: Process of speech production, Acoustic theory of speech production, Lossless tube models, and Digital models for speech signals (Text 1). Time Domain Models for Speech Processing: Time dependent processing of speech, Short time energy and average magnitude, Short time average zero crossing rate, Speech vs silence discrimination using energy & zero crossings, Pitch period estimation, Short time autocorrelation function, Short time average magnitude difference function, Pitch period estimation using autocorrelation function, Median smoothing.

Teaching-Learning Process	Chalk and Talk / Power Point Presentations.

Module-2

Digital Representations of the Speech Waveform: Sampling speech signals, Instantaneous quantization, Adaptive quantization, Differential quantization, Delta Modulation, Differential PCM, Comparison of systems, direct digital code conversion. Short Time Fourier Analysis: Linear Filtering interpretation, Filter bank summation method, Overlap addition method, Design of digital filter banks, Implementation using FFT, Spectrographic displays, Pitch detection, Analysis by synthesis, Analysis synthesis systems.

Teaching-Learning Process	Chalk and Talk / Power Point Presentations.

Module-3

Homomorphic Speech Processing: Homomorphic systems for convolution, Complex cepstrum, Pitch detection, Formant estimation, Homomorphic vocoder. Linear Predictive Coding of Speech: Basic principles of linear predictive analysis, Solution of LPC equations, Prediction error signal, Frequency domain interpretation, Relation between the various speech parameters, Synthesis of speech from linear predictive parameters, Applications.

Teaching-Learning Process	Chalk and Talk / Power Point Presentations.

Module-4

Speech Enhancement: Spectral subtraction & filtering, Harmonic filtering, parametric re-synthesis, Adaptive noise cancellation. Speech Synthesis: Principles of speech synthesis, Synthesizer methods, Synthesis of intonation, Speech synthesis for different speakers, Speech synthesis in other languages, Evaluation, Practical speech synthesis.

Teaching-Learning Process	Chalk and Talk / Power Point Presentations.

Module-5

Automatic Speech Recognition: Introduction, Speech recognition vs. Speaker recognition, Signal processing and analysis methods, Pattern comparison techniques, Hidden Markov Models, Artificial Neural Networks. Audio Processing: Auditory perception and psychoacoustics - Masking, frequency and loudness perception, spatial perception, Digital Audio, Audio Coding - High quality, low-bit rate audio coding standards, MPEG, AC- 3, Multichannel audio - Stereo, 3D

binaural and Multichannel surround sound.

Teaching-Learning Process	Chalk and Talk / Power Point Presentations.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks or one Skill Development Activity of 40 marks**

to attain the COs and POs

The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

3. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
4. The question paper will have ten full questions carrying equal marks.
5. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
6. Each full question will have a sub-question covering all the topics under a module.
7. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Books

1. L. R. Rabiner and R. W. Schafer, 'Digital Processing of Speech Signals', Pearson Education (Asia) Pvt. Ltd., 2004.
2. L. R. Rabiner and B. Juang, 'Fundamentals of Speech Recognition', Pearson Education (Asia) Pvt. Ltd., 2004.
3. Z. Li and M.S. Drew, 'Fundamentals of Multimedia', Pearson Education (Asia) Pvt. Ltd., 2004.
4. D. O'Shaughnessy, 'Speech Communications: Human and Machine', Universities Press, 2001.
1.

Web links and Video Lectures (e-Resources):

https://www.mooc.org/
https://onlinecourses.nptel.ac.in/

Skill Development Activities Suggested

Design and implement the hardware circuit to acquire the speech signals
Design and implement using the software to process the speech signals

Course Outcomes

At the end of the course the student will be able to :

Sl. No.	Description	Blooms Level
CO1	Understand basic concepts of speech production, speech analysis and synthesis	L1 L2
CO2	Analyze Speech coding techniques, Speech and speaker recognition systems.	L2 L4
CO3	Explain the Concepts of Audio Processing and learn modeling	L2
CO4	Implement Applications such as New audiogram matching techniques	L2 L3
CO5	Develop systems for various applications of speech processing.	L3

Advanced Embedded System			
Course Code	**22LSP333**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40 hours Theory	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

- Understand the basic hardware components and their selection method based on the characteristics and attributes of an embedded system.
- Describe the hardware software co-design and firmware design approaches
- Explain the architectural features of ARM CORTEX M3, a 32 bit microcontroller including memory map, interrupts and exceptions.
- Program ARM CORTEX M3 using the various instructions, for different applications.

Module-1

Embedded System: Embedded vs General computing system, classification, application and purpose of ES. Core of an Embedded System, Memory, Sensors, Actuators, LED, Opto coupler, Communication Interface, Reset circuits, RTC, WDT, Characteristics and Quality Attributes of Embedded Systems

Teaching-Learning Process	Chalk and Talk / Power Point Presentations.

Module-2

Hardware Software Co-Design, embedded firmware design approaches, computational models, embedded firmware development languages, Integration and testing of Embedded Hardware and firmware, Components in embedded system development environment (IDE), Files generated during compilation, simulators, emulators and debugging

Teaching-Learning Process	Chalk and Talk / Power Point Presentations.

Module-3

ARM-32 bit Microcontroller: Thumb-2 technology and applications of ARM, Architecture of ARM Cortex M3, Various Units in the architecture, General Purpose Registers, Special Registers, exceptions, interrupts, stack operation, reset sequence

Teaching-Learning Process	Chalk and Talk / Power Point Presentations.

Module-4

Instruction Sets: Assembly basics, Instruction list and description, useful instructions, Memory Systems, Memory maps, Cortex M3 implementation overview, pipeline and bus interface

Teaching-Learning Process	Chalk and Talk / Power Point Presentations.

Module-5

Exceptions, Nested Vector interrupt controller design, Systick Timer, Cortex-M3 Programming using assembly and C language, CMSIS

Teaching-Learning Process	Chalk and Talk / Power Point Presentations.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks or one Skill Development Activity of 40 marks**

to attain the COs and POs

The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

3. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
4. The question paper will have ten full questions carrying equal marks.
5. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
6. Each full question will have a sub-question covering all the topics under a module.
7. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Books

Text Books:

1. K. V. Shibu, "Introduction to embedded systems", TMH education Pvt. Ltd. 2009.
2. Joseph Yiu, "The Definitive Guide to the ARM Cortex-M3", 2nd edn, Newnes, (Elsevier), 2010.
3. James K. Peckol, "Embedded systems- A contemporary design tool", John Wiley, 2008.

Web links and Video Lectures (e-Resources):

https://www.mooc.org/
https://onlinecourses.nptel.ac.in/

Skill Development Activities Suggested

Design and write a assembly code to implement various interfacing experiments using ARM microcontroller

Course Outcomes

At the end of the course the student will be able to :

Sl. No.	Description	Blooms Level
CO1	Understand the basic hardware components and their selection method based on the characteristics and attributes of an embedded system.	L1 L2
CO2	Explain the hardware software co-design and firmware design approaches.	L2 L4
CO3	Acquire the knowledge of the architectural features of ARM CORTEX M3, a 32 bit microcontroller including memory map, interrupts and exceptions.	L2 L4
CO4	Apply the knowledge gained for Programming ARM CORTEX M3 for different applications.	L1 l2

Wireless Sensor Networks			
Course Code	**22LSP334**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40 hours Theory	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

- To understand wireless sensor networks
- To describe the various sensor networks
- To understand the measurement of various transport layers and application layer
- To understand the time synchronization and localization

Module-1

Introduction: Sensor Mote Platforms, WSN Architecture and Protocol Stack

WSN Applications: Military Applications, Environmental Applications, Health Applications, Home Applications, Industrial Applications

Teaching-Learning Process	Chalk and Talk / Power Point Presentations.

Module-2

Factors Influencing WSN Design: Hardware Constraints Fault Tolerance Scalability Production Costs WSN Topology, Transmission Media, Power Consumption

Physical Layer: Physical Layer Technologies, Overview of RF Wireless Communication, Channel Coding (Error Control Coding), Modulation, Wireless Channel Effects, PHY Layer Standards

Teaching-Learning Process	Chalk and Talk / Power Point Presentations.

Module-3

Medium Access Control: Challenges for MAC, CSMA Mechanism, Contention-Based Medium Access, Reservation-Based Medium Access, Hybrid Medium Access
Network Layer: Challenges for Routing, Data-centric and Flat Architecture Protocols, Hierarchical Protocols, Geographical Routing Protocols

Teaching-Learning Process	Chalk and Talk / Power Point Presentations.

Module-4

Transport Layer: Challenges for Transport Layer, Reliable Multi Segment Transport (RMST) Protocol, Pump Slowly, Fetch Quickly (PSFQ) Protocol, Congestion Detection and Avoidance (CODA) Protocol, Event-to-Sink Reliable Transport (ESRT) Protocol, GARUDA

Application Layer: Source Coding (Data Compression), Query Processing, Network Management

Teaching-Learning Process	Chalk and Talk / Power Point Presentations.

Module-5

Time Synchronization: Challenges for Time Synchronization, Network Time Protocol, Timing-Sync Protocol for Sensor Networks (TPSN), Reference- Broadcast Synchronization (RBS), Adaptive Clock Synchronization (ACS)

Localization; Challenges in Localization, Ranging Techniques, Range-Based Localization Protocols, Range-Free Localization Protocols

Teaching-Learning Process	Chalk and Talk / Power Point Presentations.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks or one Skill Development Activity of 40 marks**

to attain the COs and POs

The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

3. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
4. The question paper will have ten full questions carrying equal marks.
5. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
6. Each full question will have a sub-question covering all the topics under a module.
7. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Books

1. Ian F. Akyildiz and Mehmet Can Vuran, 'Wireless Sensor Networks', John Wiley & Sons Ltd. ISBN 978-0-470-03601-3 (H/B), 2010
2. Ananthram Swami, 'Wireless Sensor Networks: Signal Processing and Communications Perspectives', et. al., John Wiley & Sons Ltd., ISBN 978-0470-03557-3, 2007

Web links and Video Lectures (e-Resources):

https://www.mooc.org/
https://onlinecourses.nptel.ac.in/

Skill Development Activities Suggested

To test the various wireless sensor network protocols

Course Outcomes:

At the end of the course the student will be able to :

Sl. No.	Description	Blooms Level
CO1	Acquire knowledge of characteristics of mobile/wireless communication channels	L1 L2
CO2	Apply statistical models of multipath fading	L2 L4
CO3	Understand the multiple radio access techniques, radio standards and communication protocols to be used for wireless sensor	L2
CO4	Design wireless sensor network system for different applications under consideration.	L2 L4
CO5	Understand the hardware details of different types of sensors and select right type of sensor for various applications.	L3 L4

Statistical Signal Processing			
Course Code	**22LSP335**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40 hours Theory	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

- To understand and analyze the parametric method and non parametric methods
- To understand and analyze the adaptive filter algorithms

Module-1	
Random Processes: Random variables, random processes, white noise, filtering random processes, spectral factorization, ARMA, AR and MA processes	
Teaching-Learning Process	Chalk and Talk / Power Point Presentations.

Module-2	
Signal Modeling: Least squares method, Padé approximation, Prony's method, finite data records, stochastic models, Levinson-Durbin recursion; Schur recursion; Levinson recursion	
Teaching-Learning Process	Chalk and Talk / Power Point Presentations.

Module-3	
Spectrum Estimation: Nonparametric methods, minimum-variance spectrum estimation, maximum entropy method, parametric methods, frequency estimation, principal components spectrum estimation	
Teaching-Learning Process	Chalk and Talk / Power Point Presentations.

Module-4	
Optimal and Adaptive Filtering: FIR and IIR Wiener filters, Discrete Kalman filter, FIR Adaptive filters: Steepest descent, LMS, LMS-based algorithms	
Teaching-Learning Process	Chalk and Talk / Power Point Presentations.

Module-5	
Array Processing: Array fundamentals, beam-forming, optimum array processing, performance considerations, adaptive beam forming, linearly constrained minimum-variance beam-formers, side-lobe cancellers	
Teaching-Learning Process	Chalk and Talk / Power Point Presentations.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks or one Skill Development Activity of 40 marks**

to attain the COs and POs

The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

3. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
4. The question paper will have ten full questions carrying equal marks.
5. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
6. Each full question will have a sub-question covering all the topics under a module.
7. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Books

1.'Statistical Digital Signal Processing and Modelling', Monson H Hayes, John Wiley & Sons (Asia) Pvt. Ltd., 2002.
2.'Statistical and Adaptive Signal Processing: Spectral Estimation, Signal Modelling, Adaptive Filtering and Array Processing', Dimitris G. Manolakis, Vinay K. Ingle, and Stephen M. Kogon, McGraw Hill International Edition, 2000.

Web links and Video Lectures (e-Resources):

https://www.mooc.org/
https://onlinecourses.nptel.ac.in/

Skill Development Activities Suggested

Design and implement using the software to process the various statistical signal processing algorithms

Course Outcomes

At the end of the course the student will be able to :

Sl. No.	Description	Blooms Level
CO1	Able to understand and implement the digital filter design and least square sense	L2 L3
CO2	Able to understand and implement the parametric and non parametric methods of spectral estimation	L2 L3
CO3	Able to analyze forward and backward linear prediction of a stationary random process using Levinson-Durbin Algorithm	L4
CO4	Able to understand and analyze adaptive filters and its application using LMS algorithm & RLS algorithm.	L2 L4

PROJECT WORK PHASE - 1			
Course Code	**22LSP34**	CIE Marks	100
Teaching Hours/Week (L:P:SDA)	(0:6:0)	SEE Marks	-
Total Hours of Pedagogy	40 hours Practical	Total Marks	100
Credits	03	Exam Hours	-

Course Learning objectives: This course will enable students to:

- Support independent learning.
- Guide to select and utilize adequate information from varied resources maintaining ethics.
- Guide to organize the work in the appropriate manner and present information (acknowledging the sources) clearly.
- Develop interactive, communication, organization, time management, and presentation skills.
- Impart flexibility and adaptability.
- Inspire independent and team working.
- Expand intellectual capacity, credibility, judgement, intuition.
- Adhere to punctuality, setting and meeting deadlines.
- Instill responsibilities to oneself and others.
- Train students to present the topic of project work in a seminar without any fear, face audienceconfidently, enhance communication skill, involve in group discussion to present and exchange ideas.

Project Work Phase-1: The project work shall be carried out individually. However, in case a disciplinary or interdisciplinary project requires more participants, then a group consisting of not more than three shall be permitted.

Students in consultation with the guide/co-guide (if any) in disciplinary project or guides/co-guides (if any) of all departments in case of multidisciplinary projects, shall pursue a literature survey and complete the preliminary requirements of the selected Project work. Each student shall prepare a relevant introductory project document, and present a seminar.

Seminar: Each student, under the guidance of a Faculty, is required to

- Present the seminar on the selected project orally and/or through power point slides.
- Answer the queries and involve in debate/discussion.
- Submit two copies of the typed report with a list of references.

The participants shall take part in discussion to foster friendly and stimulating environment in which the students are

motivated to reach high standards and become self-confident.

Course outcomes: At the end of the course the student will be able to:

1. Demonstrate a sound technical knowledge of their selected project topic.
2. Undertake problem identification, formulation and solution.
3. Design engineering solutions to complex problems utilizing a systems approach.
4. Communicate with engineers and the community at large in written an oral forms.
5. Demonstrate the knowledge, skills and attitudes of a professional engineer.

Continuous Internal Evaluation

CIE marks shall be awarded by a committee comprising of HoD as Chairman, all Guide/s and co-guide/s (if any) and a senior faculty of the concerned departments. The CIE marks awarded for project work phase -1, shall be based on the evaluation of Project Report, Project Presentation skill, and performance in the Question

and Answer session in the ratio of 50:25:25. **RBT Level: L3, L4, L5, L6**

SOCIETAL PROJECT			
Course Code	**22LSP35**	CIE Marks	100
Teaching Hours/Week (L:P:SDA)	(0:6:0)	SEE Marks	-
Total Hours of Pedagogy	40 hours Practical	Total Marks	100
Credits	03	Exam Hours	-

Course Learning objectives: This course will enable students to:

- Support independent learning.
- Guide to select and utilize adequate information from varied resources maintaining ethics.
- Guide to organize the work in the appropriate manner and present information (acknowledging the sources) clearly.
- Develop interactive, communication, organisation, time management, and presentation skills.
- Impart flexibility and adaptability.
- Inspire independent and team working.
- Expand intellectual capacity, credibility, judgement, intuition.
- Adhere to punctuality, setting and meeting deadlines.
- Instil responsibilities to oneself and others.
- Train students to present the topic of project work in a seminar without any fear, face audience confidently, enhance communication skill, involve in group discussion to present and exchange ideas.

Societal Project: Students in consultation with the internal guide as well as with external guide (much preferable) shall involve in applying technology to workout/proposing viable solutions for societal problems.

Seminar: Each student, under the guidance of a Faculty, is required to

- Present the seminar on the selected project orally and/or through power point slides.
- Answer the queries and involve in debate/discussion.
- Submit two copies of the typed report with a list of references.

The participants shall take part in discussion to foster friendly and stimulating environment in which the students are motivated to reach high standards and become self-confident.

Course outcomes: At the end of the course the student will be able to:

1. Demonstrate a sound technical knowledge of their selected project topic.
2. Undertake societal problem identification, formulation and solution.
3. Design engineering solutions to complex societal problems utilizing a systems approach.
4. Communicate with engineers and the community at large in written an oral forms.
5. Demonstrate the knowledge, skills and attitudes of a professional engineer.

Continuous Internal Evaluation

CIE marks shall be awarded by a committee comprising of HoD as Chairman, Guide/co-guide if any, and a senior faculty of the department. The CIE marks awarded, shall be based on the evaluation of Project Report, Project Presentation skill, and performance in the Question and Answer session in the ratio of **50:25:25**.

NOTE: Those, who have not pursued /completed the Societal Project, shall be declared as fail in the course and have to complete the same during subsequent semester/s after satisfying the Societal Project requirements. There is no SEE (University examination) for this course.

RBT Level: L3, L4, L5, L6

INTERNSHIP			
Course Code	**22LSPI36**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	06 weeks Internship Completed during the intervening vacation ofII and III semesters.	SEE Marks	50
Total Hours of Pedagogy		Total Marks	100
Credits	06	Exam Hours	3

Course Learning objectives: This course will enable students to:

- Internship provide students the opportunity of hands-on experience that include personal training, time and stress management, interactive skills, presentations, budgeting, marketing, liability and risk management, paperwork, equipment ordering, maintenance, responding to emergencies etc. The objectives are further,
- To put theory into practice.
- To expand thinking and broaden the knowledge and skills acquired through course work in the field.
- To relate to, interact with, and learn from current professionals in the field.
- To gain a greater understanding of the duties and responsibilities of a professional.
- To understand and adhere to professional standards in the field.
- To gain insight to professional communication including meetings, memos, reading, writing, publicspeaking, research, client interaction, input of ideas, and confidentiality.
- To identify personal strengths and weaknesses.
- To develop the initiative and motivation to be a self-starter and work independently

Internship: All the students shall have to undergo a mandatory internship of **06 weeks** during the vacation of II and III semesters. A University examination shall be conducted during III semester and the prescribed internship credit shall be counted in the same semester. The internship shall be considered as a head of passing and shall be considered for vertical progression as well as for the award of degree.

Students under the guidance of internal guide/s and external guide shall take part in all the activities regularly to acquire as much knowledge as possible without causing any inconvenience at the place of internship.

Seminar: Each student is required to

- Present the seminar on the internship orally and/or through power point slides.
- Answer the queries and involve in debate/discussion.
- Submit the report duly certified by the external guide.

The participants shall take part in discussion to foster friendly and stimulating environment in which the students are motivated to reach high standards and become self-confident.

Course outcomes: At the end of the course the student will be able to:

- Gain practical experience within industry in which the internship is done.
- Acquire knowledge of the industry in which the internship is done.
- Apply knowledge and skills learned to classroom work.
- Develop a greater understanding about career options while more clearly defining personal careergoals.
- Experience the activities and functions of professionals.
- Develop and refine oral and written communication skills.
- Identify areas for future knowledge and skill development.
- Expand intellectual capacity, credibility, judgment, intuition.

- Acquire the knowledge of administration, marketing, finance and economics

Continuous Internal Evaluation

CIE marks shall be awarded by a committee comprising of HoD as Chairman, Guide/co-guide if any, and a senior faculty of the department. The CIE marks awarded for project work phase -1, shall be based on the evaluation of Project Report, Project Presentation skill, and performance in the Question and Answer session inthe ratio of **50:25:25**.

Semester End Examination

SEE marks for the Internship Report (30 Marks), Seminar (15 Marks) and Question and Answer Session (15 marks) shall be awarded (based on the quality of report and presentation skill, participation in the question and answer session) by the examiners appointed by the University.

NOTE: Those, who have not pursued /completed the internship, shall be declared as fail in the internship course and have to complete the same during subsequent University examinations after satisfying the internship requirements. Internship SEE (University examination) shall be as per the University norms.

RBT Level: L3, L4, L5, L6

M.TECH IN SIGNAL PROCESSING (LSP)

Choice Based Credit System (CBCS) and Outcome Based Education (OBE)

(Effective from the academic year 2022-23)

SEMESTER –IV

PROJECT WORK PHASE - 2			
Course Code	**22LSP41**	CIE Marks	100
Teaching Hours/Week (L:P:SDA)	(0:8:0)	SEE Marks	100
Total Hours of Pedagogy	40 hours Practical	Total Marks	200
Credits	18	Exam Hours	3

Course Learning objectives: This course will enable students to:

- Support independent learning.
- Guide to select and utilize adequate information from varied resources maintaining ethics.
- Guide to organize the work in the appropriate manner and present information (acknowledging thesources) clearly.
- Develop interactive, communication, organisation, time management, and presentation skills.
- Impart flexibility and adaptability.
- Inspire independent and team working.
- Expand intellectual capacity, credibility, judgement, intuition.
- Adhere to punctuality, setting and meeting deadlines.
- Instil responsibilities to oneself and others.
- Train students to present the topic of project work in a seminar without any fear, face audienceconfidently, enhance communication skill, involve in group discussion to present and exchange ideas.

Project Work Phase-2: Students in consultation with the guide/co-guide (if any) in disciplinary project or guides/co-guides (if any) of all departments in case of multidisciplinary projects, shall continue to work of Project Work phase -1 to complete the Project work. Each student / batch of students shall prepare project report as per the norms avoiding plagiarism and present a seminar.

Seminar: Each student, under the guidance of a Faculty, is required to

- Present the seminar on the selected project orally and/or through power point slides.
- Answer the queries and involve in debate/discussion.
- Submit two copies of the typed report with a list of references.

The participants shall take part in discussion to foster friendly and stimulating environment in which the students are motivated to reach high standards and become self-confident.

Course outcomes: At the end of the course the student will be able to:

- Present the project and be able to defend it.

- Make links across different areas of knowledge and to generate, develop and evaluate ideas andinformation so as to apply these skills to the project task.
- Habituated to critical thinking and use problem solving skills
- Communicate effectively and to present ideas clearly and coherently in both the written and oral forms.

Work in a team to achieve common goal.

- Learn on their own, reflect on their learning and take appropriate actions to improve it.

Continuous Internal Evaluation

CIE marks shall be awarded by a committee comprising of HoD as Chairman, all Guide/s and co-guide/s (if any) and a senior faculty of the concerned departments. The CIE marks awarded for project work phase -2, shall be based on the evaluation of Project Report, Project Presentation skill, and performance in the Question and Answer session in the ratio of **50:25:25.**

Semester End Examination

SEE shall be at the end of IV semester. Project work evaluation and Viva-Voce examination (SEE), after satisfying the plagiarism check, shall be as per the University norms. SEE marks for the project report (50 marks), seminar (25 marks) and question and answer session (25 marks) shall be awarded (based on the quality of report and presentation skill, participation in the question and answer session) by the examiners appointed

by the University. **RBT Level: L3, L4, L5, L6**