Detailed Syllabus

Lecture-wise Breakup

Course Code	17M11EC118	**Semester Odd (specify Odd/Even**	**Semester** 1st **Session** 2021-2022 **Month from July to December**
Course Name	ADVANCED DIGITAL SIGNAL PROCESSING		
Credits	3	**Contact Hours**	3

Faculty (Names)	**Coordinator(s)**	Dr. Vineet Khandelwal
	Teacher(s) (Alphabetically)	NIL

COURSE OUTCOMES At the end of the semester, students will be able to		**COGNITIVE LEVELS**
CO1	Recall the principles of various transform techniques like Z, Chirp Z, Hilbert, Discrete Fourier transform and Fast Fourier Transform.	Applying Level (C3)
CO2	Demonstrate the ability to apply different methods to design and analyze digital FIR (Finite Impulse Response) and IIR (Infinite Impulse Response) filters with its structural realization.	Analyzing Level(C4)
CO3	Analyze Multirate signal processing and examine its application.	Analyzing Level(C4)
CO4	Comprehend different methods for designing adaptive filters and examine its application	Analyzing Level(C4)

Module No.	**Title of the Module**	**Topics in the Module**	**No. of Lectures for the module**
1.	**Review of Digital Signal Processing**	Review of discrete–time sequences and systems, Linear Shift Invariant (LSI) systems. Causality and Stability Criterion, FIR & IIR representations, Z-Transform, Discrete Fourier Transform (DFT), Fast Fourier Transform (FFT) algorithms using decimation in time and decimation in frequency techniques, Chirp Z- Transform, Hilbert Transform and applications	6
2.	**Design of IIR and**	Digital filter specifications, selection of filter type, and filter	12

	FIR Filters	order, FIR filter design; using windowing Techniques, Fourier Series and frequency sampling method, Design of IIR Filters Using Butterworth, Chebyshev and Elliptic Approximations, Frequency Transformation Techniques; approximation of derivatives, Impulse invariant method, Bilinear transformation, Structures for IIR Systems – Direct Form I & II, Cascade, Parallel, Lattice & Lattice-Ladder Structures, Structures For FIR Systems – Direct , Cascade, Parallel, Lattice & Lattice ladder Structures.	
3.	**Multirate Digital Signal Processing**	Decimation & Interpolation, Sampling rate conversion, Identities, polyphase decomposition, General polyphase framework for Decimator and Interpolator, Multistage decimator and Interpolator, Efficient transversal structure for Decimator and Interpolator, FIR and IIR structure for Decimator, Filter design for FIR decimator and Interpolator, Application of Multirate Signal processing.	14
4.	**Adaptive Filters**	Introduction, Application of adaptive filters, correlation structure, FIR Weiner Filter, Adaptive Direct-form FIR filters Adaptive Lattice-Ladder filters, Introduction to linear prediction, linear prediction and autoregressive modeling.	10
		Total number of Lectures	42

Evaluation Criteria

Components	**Maximum Marks**
T1	20
T2	20
End Semester Examination	35
TA	25
Total	**100**

Project Based learni

Recommended Reading material: Author(s), Title, Edition, Publisher, Year of Publication etc. (Text books, Reference Books, Journals, Reports, Websites etc. in the IEEE format)

1.	J.G. Proakis & D.G. Manolakis, "Digital Signal Processing, Principles, Algorithms and Applications", 4th Edition, PHI, 2012
2.	Aurelio Uncini, "Fundamentals of Adaptive Signal Processing", Springer Nature, Jan 2015.
3.	Tulay Adah and Simon Haykins, "Adaptive Signal Processing: Next Generation Solutions", Wiley India, 2012.

Detailed Syllabus

Lecture-wise Breakup

Course Code	20M31EC113	**Semester** :Odd 2021**(specify Odd/Even)**	**Semester** Ist **Session** 2021 -2022 **Month from July 2021 –Dec 2021**
Course Name	Introduction to Machine Learning		
Credits	3	**Contact Hours**	3

Faculty (Names)	**Coordinator(s)**	Dr. Abhinav Gupta
	Teacher(s) (Alphabetically)	Dr. Abhinav Gupta

COURSE OUTCOMES		**COGNITIVE LEVELS**
CO1	Illustrate various machine learning approaches	Understanding (C2)
CO2	Experiment with the different techniques for feature extraction and feature selection	Applying (C3)
CO3	Apply and analyze various classifier models for typical machine learning applications	Analyzing (C4)

Module No.	**Title of the Module**	**Topics in the Module**	**No. of Lectures for the module**
1.	Introduction and Basic Concepts	Linear algebra, Probability distributions, Types of Data, Linear Models for Regression, Feature Extraction and Feature Selection.	10
2.	Introduction to Neural Networks	Neuron Model and Network Architectures: Perceptron and Hamming networks. Perceptron learning rule, Steepest Descent, Stable Learning Rates. Multilayer Perceptrons: Generalization, Methods for Improving Generalization.	6
3.	Decision Tree Learning	Decision Tree Representation, Construction of Decision Trees: Entropy Impurity, Variance Impurity, Misclassification Impurity. Axis-Parallel and Oblique Decision Trees, Issuesin decision tree learning.Random Forests	9

4.	Data Clustering	Unsupervised learning, Basic clustering methods, Principal component analysis for feature reduction	6
5.	Support Vector Machines	Linear maximum margin classifier for linearly separable data, Linear soft margin classifier, Kernel induced feature spaces, Nonlinear classifiers, Regression by SVM, SVM variants.	10
		Total number of Lectures	**41**

Evaluation Criteria

Components	**Maximum Marks**
T1	20
T2	20
End Semester Examination	35
TA	25 (5 Assignment, 5 Quiz, 5 Class Participation, 10 Attendance)
Total	**100**

Recommended Reading material: Author(s), Title, Edition, Publisher, Year of Publication etc. (Text books, Reference Books, Journals, Reports, Websites etc. in the IEEE format)

1.	Applied Machine Learning, M. Gopal, McGraw Hill, 2018.
2.	Machine Learning: The New AI, E. Alpaydin, The MIT Press Essential Knowledge series, 2016.
3.	Machine Learning Yearning , Andrew Ng, Deeplearning.ai,2018**.**
4.	The Elements of Statistical Learning , T. Hastie, R. Tibshirani, J. Friedman., 2nd Edition, Springer,2008.
5.	Machine Learning, T. Mitchell, McGraw Hill, 1997.
6.	Pattern Recognition and Machine Learning, C.M. Bishop, 2nd Edition, Springer, 2011.

Detailed Syllabus

Lecture-wise Breakup

Course Code	20M31EC114	**Semester:** ODD 2021 **(specify Odd/Even)**	**Semester:** 1st **Session:** 2021-22 **Month from: Aug 2021 to Dec 2021**
Course Name	Digital Image and Video Processing		
Credits	3	**Contact Hours**	3
Faculty (Names)	**Coordinator(s)**	Richa Gupta	
	Teacher(s) (Alphabetically)	Richa Gupta	

COURSE OUTCOMES- At the completion of the course, students will be able to		**COGNITIVE LEVELS**
C115.1	familiarize with the concept of digital image formation, image structure and transform coding.	Applying Level (C3)
C115.2	understand the basics of digital image processing with necessary skills to solve practical problems.	Applying Level (C3)
C115.3	Learn fundamentals of digital video processing, motion estimation and compensation.	Applying Level (C3)
C115.4	Identify the need of image & video compression, and image & video applications.	Applying Level (C3)

Module No.	**Title of the Module**	**Topics in the module**	**No. of Lectures for the module**
1.	Fundamentals of Digital Image and Image Transform	Basics of digital image processing, Structure of the Picture Information, luminance and chrominance components, RGB components, Transform Coding, Discrete Cosine Transforms – 1 D and 2D. Energy compaction.	6
2.	Digital Image Processing	Image Enhancement - Spatial Domain Processing: Digital Negative, Contrast Stretching, Thresholding, Gray Level Slicing, Bit Plane Slicing, Log Transform and Power Law Transform. Neighborhood Processing: Averaging filters, Order statistics filters, High pass filters and High boost filters, Filtering in frequency domain: Smoothing and Sharpening filters, Image Segmentation, Image Restoration & Construction, Morphological Image Processing, Image quality assessments.	10

3.	Digital Video Processing	Digital Video Sampling and Interpolation, Video Frame Classifications, I, P and B frames, Notation, Motion Estimation and compensation, Application of motion estimation in video coding, Video Enhancement and Restoration, Video quality Assessment.	9
4.	Image Compression and Video Compression	Data Compression: Lossless Compression and Lossy Compression, Optimal codes, Construction algorithms of source codes - Huffman Codes, Error Resilient Codes–types, construction and applications, Basics of Image Compression, Joint Photographic Expert Group (JPEG) compression, Basics of Video Compression, Inter-frame and Intra-frame redundancy, Video Coding Standard – H.263++	10
5.	Image and Video Applications	Image and Video Segmentation, Biomedical Image Processing, Image Annotation, Video Annotation, Video surveillance.	8
		Total number of Lectures	**43**

Evaluation Criteria

Components	**Maximum Marks**
T1	20
T2	20
End Semester Examination	35
TA	25 (Attendance, Performance. Assignment/Quiz)
Total	**100**

Project Based Learning: Students are required to prepare a consolidated summary (including approach, limitations, pros and cons, applications, scope etc.) of any recent research paper published in reputed International Conference or International Journal related to Image and Video processing. They will submit this research assignment towards the end of the semester.

Recommended Reading material: Author(s), Title, Edition, Publisher, Year of Publication etc. (Text books, Reference Books, Journals, Reports, Websites etc. in the IEEE format)

1.	Gonzaleze and Woods, “Digital Image Processing using MATLAB”, 2nd Edition, McGraw Hill Education, 2010.
2.	K. Sayood, Introduction to data compression, Elsevier, 5th edition, 2017
3.	A Murat Tekalp, “Digital Video Processing”, Prentice Hall, 2nd Edition, 2015

Detailed Syllabus

Lecture-wise Breakup

Subject Code	**20M32EC114**	**Semester Odd**	**Semester** 1st **Session** 2021-22 **Month from** Sept 2021 to Jan 2022
Subject Name	Speech and Audio Signal Processing (Elective M.Tech MLSP)		
Credits	**3**	**Contact Hours**	**3-0-0**

Faculty (Names)	**Coordinator(s)**	Kuldeep Baderia,
	Teacher(s) (Alphabetically)	Kuldeep Baderia

COURSE OUTCOMES		**COGNITIVE LEVELS**
C125.1	Identify various classicification of speech signals and their corresponding phonetics	Applying Level (C3)
C125.2	Test for their Knowledge in understanding time domain techniques and frequency domain techniques etc.	Analyzing Level (C4)
C125.3	Explain Homomorphic signal processing and Linear predictive analysis of speech signals	Understanding Level (C2)
C125.4	Analysis of Digital Encoding of speech signal.	Analyzing Level (C4)

Module No.	**Subtitle of the Module**	**Topics in the module**	**No. of Lectures for the module**
1.	**Fundamentals of Human Speech Production**	Introduction, The Process of Speech Production, Short-Time Fourier Representation of Speech, Acoustic Phonetics , Distinctive Features of the Phonemes of American English	5
2.	**Time-Domain Methods for Speech Processing**	Short-Time Analysis of Speech, Short-Time Energy and Short-Time Magnitude, Short-Time Zero-Crossing Rate, The Short-Time Autocorrelation Function ,The Modified Short-Time Autocorrelation Function, The Short-Time Average Magnitude Difference Function	8

3.	**Frequency-Domain Representations**	Discrete-Time Fourier Analysis,Short-Time Fourier Analysis , Spectrographic Displays, Overlap Addition Method of Synthesis, Filter Bank Summation Method of Synthesis, Time-Decimated Filter Banks, Two-Channel Filter Banks, Implementation of the FBS, Method Using the FFT, OLA Revisited ,Modifications of the STFT.	8
4.	**The Cepstrum and Homomorphic Speech Processing**	Homomorphic Systems for Convolution, Homomorphic Analysis of the Speech Model , Computing the Short-Time, Cepstrum and Complex Cepstrum of Speech, Homomorphic Filtering of Natural Speech, Cepstrum Analysis of All-Pole Models Cepstrum Distance Measures	8
5.	**LINEAR PREDICTIVE ANALYSIS OF SPEECH**	Computation of the Gain for the Model ,Frequency Domain Interpretations of Linear Predictive Analysis, Solution of the LPC Equations The Prediction Error Signal	8
6	**Digital Coding of Speech Signals**	Sampling Speech Signals, A Statistical Model for Speech, Instantaneous Quantization Adaptive Quantization Quantizing of Speech, Model Parameters, General Theory of Differential Quantization, Delta Modulation ,Differential PCM (DPCM), Enhancements for ADPCM Coders ,Analysis-by-Synthesis Speech Coders, Open-Loop Speech Coders	5
		Total number of Lectures	**42**

Evaluation Criteria

Components	**Maximum Marks**
T1	20
T2	20
End Semester Examination	35
TA	25(Attendance, Performance. Assignment/Quiz)
Total	**100**

Project based Learning Component: Speech and Audio signal processing is very important part of every communication system. In this course various project based learning components have been included like STFT, Cepstrum and Homomorphic Speech Processing, analysis and recognition of speech and audio system etc. During this subject students will learn various practical aspects of speech and audio digital signal processing.

Recommended Reading material: Author(s), Title, Edition, Publisher, Year of Publication etc. (Text books, Reference Books, Journals, Reports, Websites etc. in the IEEE format)	
1.	L. Rabiner, R. Schafer, Theory and Applications of Digital Speech Processing, Pearson, 2011
2.	J. R. Deller, J. H. L. Hansen, J. G. Proakis. Discrete-Time Processing of Speech Signals. IEEE Press, 2000
3.	Daniel Jurafsky, James H. Martin, Speech and Language Processing, 2nd Edition, Pearson, 2009
4.	Dr. Shaila D. Apte, Speech and Audio processing.Wiley-India, 2019.
5.	Ben Gold and Nelson Morgan, Speech and Audio Signal Processing- Processing and Perception of Speech and Music. Wiley-India, 2006.

Detailed Syllabus

Lecture-wise Breakup

Course Code	**19M12EC112**	**Semester Odd semester (specify Odd/Even)**	**Semester 1ST Session 2021-22** Month from August 2021 to Dec 2021.
Course Name	Soft computing		
Credits	**3**	**Contact Hours**	**3**

Faculty (Names)	**Coordinator(s)**	Dr. Vijay Khare
	Teacher(s) (Alphabetically)	Dr. Vijay Khare

COURSE OUTCOMES		**COGNITIVE LEVELS**
C120. 1	Explain soft computing techniques and their roles in building intelligent machines	Understanding Level (C2)
C120.2	Apply neural networks to pattern classification and regression problems	Applying Level (C3)
C120.3	Apply fuzzy logic and genetic algorithms to handle uncertainty and optimization problems	Applying Level (C3)
C120.4	Evaluate and compare solutions by various soft computing approaches for a real time problem use existing software tools.	Evaluating Level (C 5)

Module No.	**Title of the Module**	**Topics in the Module**	**No. of Lectures for the module**
1.	Introduction	Introduction of soft computing .evolution of computing, hard computing and soft computing, soft computing methods.	2
2.	Fundamental of neural network	Introduction of neural network , Neuron models and n/w architecture Learning in Artificial Neural Networks; Supervised, Unsupervised and Competitive Learning paradigms, perceptron neural network: Adaline and Madaline	7
3.	Feed forward neural network and applications	Multi layer Feed forward neural network, back propagation algorithms and radial basis neural network, Application of neural network	8
4.	Associated Memory	Auto associative memory, Hetro associated memory bidirectional associated memory	5
5.	Unsupervised learning	LVQ(Learning Vector Quantization) Self organization map, Adaptive resonance theory	6
6.	Fuzzy logic	Introduction, classical and Fuzzy sets &operations	9

		crisprelation and fuzzy relation Fuzzy rules based system, Fuzzy Controller Design	
7.	Genetic Algorithms	Introduction of Genetic Algorithms, Genetic Operators, Crossover and mutation properties, Genetic Algorithms in Problem Solving,	8
		Total number of Lectures	**45**

Evaluation Criteria

Components	**Maximum Marks**
T1	20
T2	20
End Semester Examination	35
TA	25 (5 Assignment, 5 Quiz, 5 Class Participation, 10 Attendance)
Total	**100**

Recommended Reading material: Author(s), Title, Edition, Publisher, Year of Publication etc. (Text books, Reference Books, Journals, Reports, Websites etc. in the IEEE format)

1	Jacek M. Zurada, *Introduction to Artificial Neural Systems,Jaico Publishing House, 1994*
2	Martin T. Hagan, Howard B. Demuth, Mark Beale, *Neural Network Design-Martin Hagan,2014*
3	SimonHykins, Neural Networks And Learning Machines, Pearson Publishing House, 2016
4	S. N. Sivanandam& S. N. Deepa, Principles of Soft Computing, Wiley - India, 2018
5	Clinton Sheppard, Genetic Algorithms with Python CreateSpace Independent Publishing Platform (April 29, 2016
6	Rajasekharan and Rai, Neural Networks, Fuzzy logic, Genetic algorithms: synthesis and applications ,PHI-2013

Detailed Syllabus

Lab-wise Breakup

Course Code	20M35EC111	**Semester** ODD **(specify Odd/Even)**	**Semester** 1st **Session** 2021 -2022 **Month from** June- July
Course Name	Advanced Signal Processing Lab (MATLAB)		
Credits	3	**Contact Hours**	6

Faculty (Names)	**Coordinator(s)**	Vineet Khandelwal
	Teacher(s) (Alphabetically)	Vineet Khandelwal

COURSE OUTCOMES: At the completion of the course, students will be able to:		**COGNITIVE LEVELS**
CO1	Understand applications of MATLAB in advanced signal processing.	Understanding Level (C2)
CO2	Apply MATLAB for analysing signal operations, transformations and filtering on signals for different application areas in signal processing.	Analysing Level (C4)
C03	Apply MATLAB/Python for implementing and analysing arithmetic operations, transformations and filtering on digital images.	Analysing Level (C4)

Module No.	**Title of the Module**	**List of Experiment**	**CO**
1.	Introduction to MATLAB	Introduction to MATLAB and its various applications in advanced signal processing.	C1
2.	Introduction to Spectral Analysis	Spectral Analysis of a signal over time	C2
3.	Spectral leakage and windowing	Spectral Leakage and Windowing	C2
4.	Design of FIR filter	Design and analysis of Digital FIR filter for audio denoising .	C2

5.	Design of IIR filter	Design and analysis of Digital IIR filter for audio denoising	C2
6.	Design of Wiener filter	Design of Optimal Wiener filter for signal denoising	C2
7.	Image Deblurring	Restoration of motion blurred images with Wiener Filte	C3
8.	Image Denoising	Denoising of images using Wiener filtering	C3
9.	Image Compression	JPEG compression of images for various compression ratios	C3
10.	Virtual Lab: Colour Image Processing	To learn how to handle and process the colour images.	C3
11.	Virtual Lab: Image Processing Test Bench	To learn to build algorithms for solving problems and to build solutions using a cascade of image processing modules.	C3

Evaluation Criteria

Components	**Maximum Marks**
Viva 1(Mid Sem Viva)	20
Viva 2(End Sem Viva)	20
Assessment Components	30
Attendance	15
Lab Record	15
Total	**100**

Recommended Reading material: Author(s), Title, Edition, Publisher, Year of Publication etc. (Text books, Reference Books, Journals, Reports, Websites etc. in the IEEE format)

1.	J. UNPINGCO: Python for Signal Processing, Springer International Publishing Switzerland, 2014.
2.	M. WICKERT: Signal Processing and Communications: Teaching and Research Using IPython Notebook, In Proc. of the 14th python in science conf., (scipy. 2015).
3.	R. C. GONZALEZ, R. E. WOODS: Digital Image Processing, 4th edition, Pearson Education Inc, 2018.
4.	S. DEY: Hands-On Image Processing with Python, Packt Publishing, 2018.

Evaluation scheme for different assessment components (AC's),

1. AC1. To build up understanding of experiment (Quality)
2. AC2. Lab exercises to gain insight in to the theoretical concepts (Quantity)

Every Experiment has two AC's, each of 10 Marks. If in total 10 experiments are there, then total 300 marks, which will be scaled down to 30 at the end.

During Mid Sem Viva and End Sem Viva, 20 Marks are divided as

(i) 10 marks for viva and
(ii) 10 marks for performance.

Course Description

Course Code	**18M11GE111**	**Semester** Odd	**Semester** I **Session** 2021-22 **Month from** July 2021 - Dec 2021
Course Name	Research Methodology & Intellectual Property Rights		
Credits	2	**Contact Hours**	2-0-0
Faculty (Names)	**Coordinator(s)**	Prof. B.P.Chamola	
	Teacher(s) (Alphabetically)	Prof. B.P. Chamola	

COURSE OUTCOMES:		**COGNITIVE LEVELS**
After pursuing the above mentioned course, the students will be able to:		
C101.1	explain the basic concepts and types of research	Understanding Level (C2)
C101.2	define a research problem, its formulation, methodologies and analyze research related information	Analyzing Level (C4)
C101.3	explain research ethics, understand IPR, patents and their filing related to their innovative works.	Understanding Level (C2)
C101.4	explain and analyzethe statistical data and apply the relevant test of hypothesis in their research problems	Analyzing Level (C4)

Module No.	**Title of the Module**	**Topics in the Module**	**No. of Lectures for the module**
1.	Research	What is research? Types of research. What is not research? How to read a Journal paper?	3
2.	Report writing	How to write report? Use of Mendeley in report writing. How to write a research paper? Problem identification and solving.	4
3.	Ethics, IPR and Research methodologies	Research ethics, patents, intellectual property rights, plagiarism regulation 2018. Steps in research process and common methodologies to attempt solution to research paper.	8
4.	Basics of statistics and probability distributions	Basic statistical concepts. Handling of raw data, Some common probability distributions.	7
5.	Test of hypothesis and regression	Hypothesis testing. Parametric and non-parametric data, Introduction to regression	8

	analysis	analysis.	
		Total number of Lectures (Course delivery method: open ended discussion, guided self-study, lectures)	**30**

Evaluation Criteria

Components	**Maximum Marks**
Mid Term Examination	30
End Semester Examination	40
Assignments	30 (Quiz, Assignments)
Total	**100**

Project based learning: Students divided in small groups will be assigned topics related to patents, intellectual property rights,plagiarism,and statistics.Students can write a report/review paper and find its similarity through plagiarism software available online. Students may collect data and test the relevant hypothesis.They may study some data set and do its regression analysis. The main purpose is to expose students to a wider arena of applicable knowledge of the subject.

Recommended Reading material: Author(s), Title, Edition, Publisher, Year of Publication etc. (Text books, Reference Books, Journals, Reports, Websites etc. in the IEEE format)

Stuart Melville and Wayne Goddard, Research Methodology: An Introduction for Science & Engineering Students, Kenwyn, South Africa: Juta & Co. Ltd., 1996.

Kothari, C.R., Research Methodology: Methods and Techniques, New Age International, New Delhi, 2009.

Kumar, Ranjit, Research Methodology: A Step by Step Guide for Beginners, 2nd Edition, Sage Publications Ltd., 2005.

Ramappa, T., Intellectual Property Rights Under WTO, S. Chand, New Delhi, 2008.

Wayne Goddard and Stuart Melville, Research Methodology: An Introduction, Kenwyn, South Africa: Juta & Co, 2001.