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

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.

Detailed Syllabus

Lecture-wise Breakup

Course Code	20M31EC115	**Semester even**	**Semester II Session** 2021 -2022 **Month from** Feb 22 to Jun 22
Course Name	Deep Learning and Applications		
Credits	3	**Contact Hours**	3

Faculty (Names)	**Coordinator(s)**	Dr. Neetu Singh
	Teacher(s) (Alphabetically)	Dr. Neetu Singh

COURSE OUTCOMES		**COGNITIVE LEVELS**
C113.1	Compare various loss functions and optimization methods for deep learning approaches	Understanding (C2)
C113.2	Experiment with various CNN architectures for related applications	Apply (C3)
C113.3	Apply and analyze sequence models for related applications	Analyzing (C4)

Module No.	**Title of the Module**	**Topics in the Module**	**No. of Lectures for the module**
1.	Introduction and Basic concepts	Introduction to Deep Learning, Bayesian Learning, Decision Surfaces, Linear Classifiers, Linear Machines with Hinge Loss, Optimization Techniques, Gradient Descent, Batch Optimization.	6
2.	Introduction to Neural Networks, Backpropagation and Generalization	Perceptron learning rule and proof of convergence. Performance surfaces and optimum points, Backpropagation: Multilayer Perceptrons, Function Approximation, Performance Index, Chain Rule, Backpropagating the Sensitivities. Various Loss Functions. Vapnik–Chervonenkis dimension.	6

3.	Convolutional Neural Network (CNN) Architectures	Layers for Conv Nets, Feature Maps and Pooling, FC layer to Conv layer conversion, Feature visualization, Batch normalization, Object detection using CNN, CNN architectures: MobileNet, Frequency CNN. Applications of CNN to multimedia.	12
4.	Sequence Models	Recurrent Neural Networks, Adding Feedback Loops and Unfolding a Neural Network, Long Short-Term Memory, Recurrent Neural Network for word predictions, Neural Language Models: Word Embeddings and Word Analogies. Image captioning, Visual question answering, Soft attention, Autoencoders.	12
5.	Generative Adversarial Networks	Introduction to GANs and generative modeling, Various GAN architectures and applications, Deep Reinforcement Learning.	5
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 PBL, 10 Attendance)
Total	**100**

Project based learning: Students will apply various CNN models for the image classification and object recognition problems with the help of programming assignments. Additionally, Long Short-Term Memory model in conjunction with CNN will be implemented by the students to study the image captioning and visual question answering. Moreover, every student will prepare a review of the CNN-LSTM applications using current research papers.

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.	Introduction to Deep Learning, S. Kansi, Springer 2018.
2.	Deep Learning, I. Goodfellow, Y, Bengio, A. Courville, MIT Press, 2016.
3.	GANs in Action: Deep learning with Generative Adversarial Networks, J. Langr, V. Bok,

	Manning Publications, 2019.
4.	Pattern Classification- Richard O. Duda, Peter E. Hart, David G. Stork, John Wiley & Sons Inc., 2nd Edition, 2001.

Detailed Syllabus
Course Outcomes

Course Code	**17I17EC511/17M17EC219/ 17M27EC215/**17M17EC222 /17I17EC511	**Semester ODD**	**Semester** 3rd& 4thfor M.Tech / 11th for Dual Degree **Session** 2021 - 2022 **Month from** July to Dec
Course Name	Dissertation		
Credits	M.Tech–4 &16 DD - 22	**Contact Hours**	8 & 32

Faculty (Names)	**Coordinator(s)**	Dr. Rachna Singh, Dr Kirmender Singh
	Teacher(s) (Alphabetically)	All faculty of ECE Deptt.

COURSE OUTCOMES		**COGNITIVE LEVELS**
C213.1	Summarize the contemporary scholarly literature, activities, and explored tools/ techniques/software/hardware for hands-on in the respective project area in various domain of Electronics Engineering.	Understanding Level (C2)
C213.2	Gain knowledge of the State-of-Art in the chosen field of study. Analyze various feasible methods of solving a problem to slot a suitable solution methodology	Analyzing Level (C4)
C213.3	Use latest techniques and software tools for achieving the defined objectives. Evaluate /Validate sound conclusions based on evidence and analysis	Evaluating Level (C5)
C213.4	Demonstrate the oral and written communication skills. Describe the importance of possible future developments in the selected domain	Creating Level (C6)

Evaluation Criteria

(Dissertation at the end of third semester for M.Tech only)

Components	**Maximum Marks**
End Term Viva	60
Day to Day	40
Total	**100**

(Dissertation at the end of final semester for M.Tech/DD)

Components	**Maximum Marks**
End Term Viva	50
Special Contribution	10
Day to Day	40
Total	**100**

Detailed Syllabus
Course Outcomes

Course Code	**17I17EC511/17M17EC219/ 17M27EC215/**17M17EC222 /17I17EC511	**Semester EVEN**	**Semester** 3rd& 4thfor M.Tech / 11th for Dual Degree **Session** 2021 - 2022 **Month from** Jan to May
Course Name	Dissertation		
Credits	M.Tech–4 &16 DD - 22	**Contact Hours**	8 & 32

Faculty (Names)	**Coordinator(s)**	Dr. Rachna Singh, Dr Kirmender Singh
	Teacher(s) (Alphabetically)	All faculty of ECE Deptt.

COURSE OUTCOMES		**COGNITIVE LEVELS**
C213.1	Summarize the contemporary scholarly literature, activities, and explored tools/ techniques/software/hardware for hands-on in the respective project area in various domain of Electronics Engineering.	Understanding Level (C2)
C213.2	Gain knowledge of the State-of-Art in the chosen field of study. Analyze various feasible methods of solving a problem to slot a suitable solution methodology	Analyzing Level (C4)
C213.3	Use latest techniques and software tools for achieving the defined objectives. Evaluate /Validate sound conclusions based on evidence and analysis	Evaluating Level (C5)
C213.4	Demonstrate the oral and written communication skills. Describe the importance of possible future developments in the selected domain	Creating Level (C6)

Evaluation Criteria

(Dissertation at the end of third semester for M.Tech only)

Components	**Maximum Marks**
End Term Viva	60
Day to Day	40
Total	**100**

(Dissertation at the end of final semester for M.Tech/DD)

Components	**Maximum Marks**
End Term Viva	50
Special Contribution	10
Day to Day	40
Total	**100**

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

Lab-wise Breakup

Course Code	20M35EC112	**Semester** Even **(specify Odd/Even)**	**Semester** 2nd **Session** 2021 -2022 **Month from** Feb - Jun
Course Name	Machine Learning Lab (Python)		
Credits	3	**Contact Hours**	6

Faculty (Names)	**Coordinator(s)**	Neetu Singh
	Teacher(s) (Alphabetically)	Neetu Singh, Vijay Khare, Vivek Dwivedi

COURSE OUTCOMES: At the completion of the course, students will be able to:		**COGNITIVE LEVELS**
C172.1	Apply Python for implementation of machine learning algorithms to solve real-life problems.	Understanding Level (C2)
C172.2	Apply Python for implementation of ANN and Genetic algorithms to solve real-life problems.	Analysing Level (C4)
C172.3	Apply Python for implementation of deep learning algorithms to solve real-life problems.	Analysing Level (C4)

Module No.	**Title of the Module**	**List of Experiments**	**CO**
1.	Parametric regression	Fit the data points using a parametric Regression algorithm for the given data set.	C172.1
2.	Non-parametric regression	Fit the data points using a non-parametric Regression algorithm for the given data set.	C172.1
3.	Bayesian Learning	Implementation of naive Bayesian Classifier model to perform classification between images of the given image data set.	C172.1
4.	Bayesian Network	Construction of a Bayesian network classifier on medical data and demonstration of the diagnosis of a disease using standard	C172.1

		Disease Data Set.	
5.	Unsupervised Learning (Clustering)	Implement/Demonstrate EM, k-means algorithm for clustering of the given data. Compare the efficiency of two algorithms in clustering.	C172.1
6.	Supervised Learning (KNN and SVM)	Implement/Demonstrate k-Nearest neighbour algorithm (KNN) and Support Vector Machines (SVM) to classify a given standard data set.	C172.1
7.	Decision Trees	Implementation of the working of the decision tree based ID3 algorithm.	C172.1
8.	Evaluating Hypothesis	For a given set of training data, implementation of the FIND-S algorithm for finding the most specific hypothesis.	C172.1
9.	Neuron model	Implement the basic logic gates using basic neuron model.	C172.2
10.	Perceptron	Create a single layer perceptron with appropriate number of inputs and outputs. Train it using a fixed increment learning algorithm until no change in weights is required. Output the final weights.	C172.2
11.	Back propagation	Write a program to implement multilayer neural network with back propagation algorithm for given data .	C172.2
12.	RBF Neural network	Write a program to implement multilayer neural network with back propagation algorithm for given data	C172.2
13.	Neuron model	Implement the basic logic gates using basic neuron model	C172.2
14.	Genetic Algorithms	Implement travelling salesperson problem (TSP) using genetic algorithms. Outline learning rule, perceptron, back propagation, fuzzy logic and genetic algorithms.	C172.2
15.	Keras	Introduction to Python deep learning with Keras.	C172.3
16.	CNN	Implementation of a Convolutional Neural Network (CNN) for image classification.	C172.3
17.	Tuning CNN	Tune implemented CNN for better accuracy, convergence rate and lesser training time.	C172.3
18.	RNN	Implementation of Recursive Neural Network (RNN) for text	C172.3

		classification.	
19.	RNN	Implementation of Recursive Neural Network (RNN) for speech recognition.	C172.3
20.	Deep belief network	Implementation of unsupervised learning (deep belief network) for image recognition.	C172.3

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.	R. DUDA, H. PETER , and S. DAVID Stork: Pattern Classification, 2nd ed. New York, NY: Wiley-Interscience, 2000.
2.	T. MITCHELL: Machine Learning, New York, NY: McGraw-Hill, 1997.
3.	M. GOPAL: Applied Machine Learning, M. Gopal, McGraw Hill, 2018.
4.	E. ALPAYDIN: Machine Learning: The New AI, The MIT Press Essential Knowledge series, 2016.
5.	R. C. GONZALEZ, R. E. WOODS: Digital Image Processing, 4th edition, Pearson Education Inc, 2018.
6.	S. DEY: Hands-On Image Processing with Python, Packt Publishing, 2018.

Detailed Syllabus
Lecture-wise Breakup

Subject Code		**Semester Even**	**Semester** M.Tech **Session** 2022 -2023 **Month from**
Subject Name	Multirate Signal Processing and Filter Banks		
Credits	**3**	**Contact Hours**	**3-0-0**

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

COURSE OUTCOMES		**COGNITIVE LEVELS**
CO1	Recap the concept of Digital Signal Processing.	Understanding Level (C2)
CO2	Understand the concept of Multirate Signal Processing and its Applications.	Understanding Level (C2)
CO3	Understand the concepts of Maximally Decimated Filter Banks and Paraunitary Perfect Reconstruction (PR) Filter Banks and analyze by applying Multirate Signal Processing.	Analyzing Level (C4)
CO4	Understand the concept of Linear Phase Perfect Reconstruction QMF Banks and Cosine Modulated Filter Banks and analyze by applying Multirate Signal Processing.	Analyzing Level (C4)

Module No.	**Subtitle of the Module**	**Topics in the module**	**No. of Lectures for the module**
1.	Review of Discrete-Time Systems and Digital Filters	Introduction, Discrete-Time Signals, Multi-Input Multi-Output Systems, Discrete-Time Filters (Digital Filters), Filter Design Specifications, FIR Filter Design, IIR Filter Design, Allpass Filters	5
2.	Fundamentals of Multirate Systems,	Basic Multirate Operations, Interconnection of Building Blocks, The Polyphase Representation, Multistage Implementations ,Some Applications of Multirate Systems, Special Filters and Filter Banks	6
3.	Maximally Decimated Filter Banks	Introduction, Errors Created in the QMF Bank, A Simple Alias-Free QMF System, Power Symmetric QMF Banks, M-channel Filter Banks, Polyphase Representation, Perfect Reconstruction Systems, Alias-Free Filter Banks, Tree Structured Filter Banks, Transmultiplexers	8
4.	Paraunitary Perfect Reconstruction (PR) Filter Banks	Introduction, Lossless Transfer Matrices, Filter Bank Properties Induced by Paraunitariness, Two Channel FIR Paraunitary QMF Banks ,The Two ChanneI Paraunitary QMF Lattice, M-channel FIR Paraunitary Filter Banks	8
5.	Linear Phase Perfect Reconstruction QMF Banks	Introduction, Some Necessary Conditions ,Lattice Structures for Linear Phase FIR PR QMF Banks, Formal Synthesis of Linear Phase FIR PR QMF Lattice	7
6	Cosine Modulated Filter Banks	Introduction, The Pseudo QMF Bank, Design of the Pseudo QMF Bank, Efficient Polyphase Structures, Deeper Properties of Cosine Matrices, Cosine Modulated Perfect Reconstruction Systems	8
		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: Multirate Signal Processing and Filter Banks is advance topic of Digital Signal Processing. As concern project based learning, there are various applications of this subject like speech processing, image processing, biomedical signal processing and satellite image processing etc. By understanding of this subject students are able to apply the knowledge in various fields of 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.	**P.P. Vaidyanathan, Multirate Systems and Filter Banks, Pearson Education, 1993.**
2.	N. J. Fliege, Multirate Digital Signal Processing: Multirate Systems - Filter Banks – Wavelets, Wiley, 1999.
3.	R. E. Crochiere and L.R. Rebiner, Multirate Digital Signal Processing, Pearson 1983.
4.	G. J. Dolecek, Advances in Multirate Systems, Springer International Publishing, 2017

Detailed Syllabus

Lecture-wise Breakup

Subject Code	**17M11EC129**	**Semester Even**	**Semester 2nd Session** 2021-22 **Month from** Jan 22 to Jun 22
Subject Name	**Project Based Learning - I**		
Credits	2	**Contact Hours**	2

Faculty (Names)	**Coordinator(s)**	Dr. Vivek Dwivedi
	Teacher(s) (Alphabetically)	NA

COURSE OUTCOMES		**COGNITIVE LEVELS**
C171.1	Summarize the contemporary scholarly literature, activities, and explored tools/ techniques/software/hardware for hands-on in the respective project area in various domain of Embedded Systems, Signal Processing, VLSI, Communication, Artificial Intelligence and Machine Learning/Deep Learning etc.	Understanding (Level II)
C171.2	Analyze/ Design the skill for obtaining the optimum solution to the formulated problem with in stipulated time and maintain technical correctness with effective presentation.	Analysing (Level IV)
C171.3	Use latest techniques and software tools for achieving the defined objectives.	Evaluating (Level V)
C171.4	Evaluate /Validate sound conclusions based on analysis and effectively document it in correct language and proper format.	Evaluating (Level V)

Project Based Learning Component: Every student will be assigned a project supervisor. The project supervisor will assign 4 different tasks to the student. These tasks will be evaluated by a panel of examiners in the mid and end semester. The students will explore various tools/ techniques/software/hardware for hands-on in the respective project area in various domain of Embedded Systems, Signal Processing, VLSI, Communication, Artificial Intelligence and Machine Learning/Deep Learning etc.

Evaluation Criteria	
Components	**Maximum Marks**
Mid Sem Evaluation 40	
Final Evaluation 40	
Report	20
Total	**100**

Detailed Syllabus

Lecture-wise Breakup

Subject Code	**17M11EC129**	**Semester ODD**	**Semester 3rd Session** 2021-22 **Month from** July 21 to Dec 21
Subject Name	**Project Based Learning - II**		
Credits	2	**Contact Hours**	2

Faculty (Names)	**Coordinator(s)**	Dr. Vivek Dwivedi
	Teacher(s) (Alphabetically)	NA

COURSE OUTCOMES		**COGNITIVE LEVELS**
C171.1	Summarize the contemporary scholarly literature, activities, and explored tools/ techniques/software/hardware for hands-on in the respective project area in various domain of Embedded Systems, Signal Processing, VLSI, Communication, Artificial Intelligence and Machine Learning/Deep Learning etc.	Understanding Level (C2)
C171.2	Analyze/ Design the skill for obtaining the optimum solution to the formulated problem with in stipulated time and maintain technical correctness with effective presentation.	Analyzing Level (C4)
C171.3	Use latest techniques and software tools for achieving the defined objectives.	Evaluating Level (C5)
C171.4	Evaluate /Validate sound conclusions based on analysis and effectively document it in correct language and proper format.	Evaluating Level (C5)

Project Based Learning Component: Every student will be assigned a project supervisor. The project supervisor will assign 4 different tasks to the student. These tasks will be evaluated by a panel of examiners in the mid and end semester. The students will explore various tools/ techniques/software/hardware for hands-on in the respective project area in various domain of Embedded Systems, Signal Processing, VLSI, Communication, Artificial Intelligence and Machine Learning/Deep Learning etc.

Evaluation Criteria

Components	**Maximum Marks**
Mid Sem Evaluation	40
Final Evaluation	40
Report	20
Total	**100**

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.

Detailed Syllabus
Course Outcomes

Course Code	17M17EC218	**Semester** Odd **(specify Odd/Even)**	**Semester** 3rd **Session** 2021-2022 **Month from** July to December
Course Name	Seminar & Term Paper		
Credits	4	**Contact Hours**	

Faculty (Names)	**Coordinator(s)**	Saurabh Chaturvedi
	Teacher(s) (Alphabetically)	Saurabh Chaturvedi

S. N.	**COURSE OUTCOMES:** At the completion of the course, students will be able to	**COGNITIVE LEVELS**
C212.1	Understand relevant theories, methods and research design relating to the seminar topic selected by a student.	Understanding Level (C2)
C212.2	Analyze the work of other authors/researchers and contribute to the field of knowledge with the cooperation of the supervisor.	Analyzing Level (C4)
C212.3	Evaluate the previously published research works, findings and conclusions.	Evaluating Level (C5)
C212.4	Develop and refine the master's dissertation topic and proposal. Develop the effective technical writing, communication and presentation skills.	Creating Level (C6)

Evaluation Criteria

Components	**Maximum Marks**
Mid semester viva	20
End semester viva	20
Day-to-day evaluation	40
Term paper/Report	20
Total	**100**

Detailed Syllabus

Lecture-wise Breakup

Course Code	17M11EC121	**Semester** :Even 2022	**Semester** IInd **Session** 2021 -2022 **Month from Feb 2022– June 2022**
Course Name	Statistical Signal Processing		
Credits	3	**Contact Hours**	3

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

COURSE OUTCOMES		**COGNITIVE LEVELS**
C116.1	Understand the need of random variables and random processes in signal processing.	Understanding (C2)
C116.2	Experiment with various algorithms to model the random signals.	Applying (C3)
C116.3	Apply and Analyze Wiener and adaptive filters for signal processing applications.	Analyzing (C4)

Module No.	**Title of the Module**	**Topics in the Module**	**No. of Lectures for the module**
1.	Review of Linear Algebra, Random Variables and Random Processes	Liner algebra: vectors, linear independence and vector spaces, Matrices: inverse, determinant and trace; Linear equations, quadratic and Hermitian forms, eigenvalues and eigenvectors; Random variables: Jointly distributed random variables, Joint moments, Linear mean square estimation, bias and consistency; Random process : ensemble averages, Gaussian process, stationary process, ergodicity, white noise, Linear system with random input, Spectral factorization theorem and its importance, innovation process and whitening filter.	11
2.	Random Signal Modelling	Least square method, Pade approximation, Prony's method, Stochastic models: MA(q), AR(p), ARMA(p, q)	7

		models.	
3.	Levinson-Durbin Recursion	Development of the recursion, Lattice filter and properties, Different recursion methods	7
4.	Wiener Filtering	FIR Wiener filter: Filtering, Linear prediction , Noise cancellation; IIR Wiener filter: noncausal IIR Wiener filter, causal IIR Wiener filter, causal Wiener filtering and linear prediction, Wiener deconvolution.	7
5.	Adaptive Filtering	Principle and Application, Steepest Descent Algorithm, Convergence characteristics; LMS algorithm, convergence, other LMS based adaptive filters.	6
6.	Spectral Estimation	Non parametric and parametric methods.	3
		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.	Monson H. Hayes, "Statistical Digital Signal Processing And Modeling"; John Wiley & Sons, 2004.
2.	Simon Haykin," Adaptive Filter Theory", fifth edition, Pearson, 2013.