

DELHI TECHNOLOGICAL UNIVERSITY
SCHEME OF TEACHING AND EVALUATION
MASTER OF TECHNOLOGY IN SIGNAL PROCESSING & DIGITAL DESIGN (SPD)

The following alphanumeric coding scheme has been adopted

Core Courses XXXYMN

Elective Courses XXXYCMN

XXX abbreviates a particular M. Tech. program, Y – (5 for M. Tech. 1st year, 6 for M. Tech. 2nd year),
 C – credit of the course (4/3/2),
 MN – Subject code (Odd number for odd semester and even number for even semester courses)

Semester-I														
	S. No.	Course Code	Course Name	Type/ Area	Cr	L	T	P	CWS	PRS	MTE	ETE	PRE	Total Credits
Group A	1	SPD501	Advanced Digital Signal Processing	Core	4	3	0	2	15	25	20	40	-	17
	2	SPD503	Image Analysis and Processing	Core	4	3	0	2	15	25	20	40	-	
Group B	3	SPD5401/5403/.....	Elective 1	Elective	4	3	0	2	15	25	20	40	-	
	4	SPD5301/5303/.....	Elective 2	Elective	3	3	0	0	15	25	20	40	-	
	5	SPD5201/5203/...../ UEC5201/5203/.....	Elective 3/ University Elective I	Elective	2	2/0	0	0/4	20/ 0	0/ 40	30/0	50/0	0/60	
Semester-II														
	S. No.	Course Code	Course Name	Type/ Area	Cr	L	T	P	CWS	PRS	MTE	ETE	PRE	Total Credits
Group C	1	SPD502	Pattern Analysis and Machine Intelligence	Core	4	3	0	2	15	25	20	40	-	17

	2	SPD504	Embedded System	Core	4	3	0	2	15	25	20	40	-
Group D	3	SPD5402/5404/.....	Elective 4	Elective	4	3	0	2	15	25	20	40	-
	4	SPD5302/5304/.....	Elective 5	Elective	3	3	0	0	20	-	30	50	-
	5	SPD5202/5204/...../ UEC5202/5204/.....	Elective 6/ University Elective II	Elective	2	2	0	0	20	-	30	50	-

Semester-III

	S. No.	Course Code	Course Name	Type/ Area	Cr	L	T	P	CWS	PRS	MTE	ETE	PRE	Total Credits
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Track 1

	1	SPD651	Research Project	Core	2 ¹	0		12	0	-	0	100	-	
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Track 2

Group E	1	SPD601	Major Project I	Core	3						40	60		12
	2	SPD6401/6403/.....	Elective 7	Elective	4	3/2	0	2/4	15	25	20	40	-	
	3	SPD6301/6303/.....	Elective 8	Elective	3	3	0	0	20	-	30	50	-	
	4	SPD6201/6203/.....	Elective 9	Elective	2	2	0	0	20	-	30	50	-	

Semester-IV

	S. No.	Course Code	Course Name	Type/ Area	Cr	L	T	P	CWS	PRS	MTE	ETE	PRE	Total Credits
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Group F Track 1

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1	SPD652	Research Project	Core	2 ¹	0	0	12	0	-	0	100	0	
Track 2												12	
1	SPD602	Major Project II	Core	2 ¹	0	0	12	0	-	0	100	0	

LIST OF ELECTIVES :													
	S. No.	Course Code	Course Name	Type/Area	Cr	L	T	P	CWS	PRS	MTE	ETE	PRE
Elective 1	1	SPD5401	Wireless communication	Elective	4	3	0	2	15	25	20	40	-
	2	SPD5403	Advanced Digital System Design + (concepts of Fault Tolerance)		4	3	0	2	15	25	20	40	-
	3	SPD5405	Analog Signal Processing		4	3	0	2	15	25	20	40	-
	4	SPD5407	Soft Computing		4	3	0	2	15	25	20	40	-
	S. No.	Course Code	Course Name	Type/Area	Cr	L	T	P	CWS	PRS	MTE	ETE	PRE
Elective 2	1	SPD5301	Digital Watermarking	Elective	3	3	0	0	20	-	30	50	-
	2	SPD5303	Wavelets in Signal Processing		3	3	0	0	20	-	30	50	-
	3	SPD5305	Advanced Computer Architecture		3	3	0	0	20	-	30	50	-
	4	SPD5307	Network Security & Cryptography		3	3	0	0	20	-	30	50	-
	S. No.	Course Code	Course Name	Type/Area	Cr	L	T	P	CWS	PRS	MTE	ETE	PRE
	1	SPD5201	SEMINAR		2	0	0	2	-	100	-	-	-
Elective	2	SPD5203	Language Lab	Elective	2	0	0	4	0	40	0	0	60

	3	SPD5205	Statistical Signal Processing		2	2	0	0	20	-	30	50	-
	4	SPD5207	Wireless sensor networks		2	2	0	0	20	-	30	50	-
	5	SPD5209	Real Time Operating Systems		2	2	0	0	20	-	30	50	-
	S. No.	Course Code	Course Name	Type/Area	Cr	L	T	P	CWS	PRS	MTE	ETE	PRE
Elective 4	1	SPD5402	Computer Vision	Elective	4	3	0	2	15	25	20	40	-
	2	SPD5404	IOT & Applications		4	3	0	2	15	25	20	40	-
	3	SPD5406	Speech Processing		4	3	0	2	15	25	20	40	-
	4	SPD5408	Fractional Delay Filters		4	3	0	2	15	25	20	40	-
	S.No.	Course Code	Course Name	Type/Area	Cr	L	T	P	CWS	PRS	MTE	ETE	PRE
Elective 5	1	SPD5302	MINOR PROJECT	Elective	3	0	0	-	-	40	-	-	60
	2	SPD5304	Biomedical Signal Modelling		3	3	0	0	20	-	30	50	-
	3	SPD5306	Object Tracking		3	3	0	0	20	-	30	50	-
	4	SPD5308	Optimization Techniques		3	3	0	0	20	-	30	50	-
	5	SPD5310	Artificial Intelligence		3	3	0	0	20	-	30	50	-
	6	SPD5312	Reconfigurable Computing		3	3	0	0	20	-	30	50	-
	S.No.	Course Code	Course Name	Type/Area	Cr	L	T	P	CWS	PRS	MTE	ETE	PRE

Elective 6	1	SPD5202	Research Methodology & Report writing	Elective	2	2	0	0	20	-	30	50	-
	2	SPD5208	VLSI Signal processing Architecture		2	2	0	0	20	-	30	50	-
	S.No.	Course Code	Course Name	Type/Area	Cr	L	T	P	CWS	PRS	MTE	ETE	PRE
Elective 7	1	SPD6401	Multispectral signal Analysis	Elective	4	3/2	0/0	2/4	15	25	20	40	-
	2	SPD6403	Testing and Diagnosis of Digital system design		4	3/2	0/0	2/4	15	25	20	40	-
	3	SPD6405	Detection and estimation theory		4	3/2	0/0	2/4	15	25	20	40	-
	4	SPD6407	Digital Design and verification		4	3/2	0/0	2/4	15	25	20	40	-
	S.No.	Course Code	Course Name	Type/Area	Cr	L	T	P	CWS	PRS	MTE	ETE	PRE
Elective 8	1	SPD6301	Data Analytics	Elective	3	3	0	0	20	-	30	50	-
	2	SPD6303	SOC Design testing and verification		3	3	0	0	20	-	30	50	-
	3	SPD6305	FPGA Based System Design		3	3	0	0	20	-	30	50	-
	4	SPD6307	Biomedical Signal & image processing		3	3	0	0	20	-	30	50	-
		S.No.	Course Code		Course Name	Type/Area	Cr	L	T	P	CWS	PRS	MTE

SEMESTER I

Courses

SPD501 Advanced Digital Signal Processing

Review of Discrete time signals and systems and frequency analysis of discrete time linear time invariant systems. Discrete time systems, analysis of discrete time linear invariant systems, implementation of discrete time systems, correlation of discrete time systems, Z- Transforms, linear time invariant systems as frequency selective filters. Sampling. The Discrete Fourier transforms its properties and applications. Frequency domain sampling, properties of DFT, linear filtering methods based on DFT, Frequency analysis of signals using the DFT, Radix-2 decimation in time domain and decimation in frequency domain algorithms. Design of Digital filters, Design of FIR filters, Design of IIR filters, frequency transformations. Multirate digital signal processing, Decimation, interpolation, sampling rate conversion, filterdesign and implementation for multirate conversion, sampling rate conversion by an arbitrary factor, applications of multirate signal processing. Linear prediction and optimum linear filters, Forward and backward linear prediction, solution of the normal equations, wiener filters. Power spectrum estimation, Non-parametric and parametric methods for power spectrum estimation.

Suggested Books:

1. J.G. Proakis and Nikias, “Advanced Digital Signal Processing”, Pearson Publications, 2002.
2. J.G. Proakis and D.G. Manolakis, “Digital Signal Processing”, Pearson Publications, 2007.
3. G. Zelniker and F.J. Taylor, “Advanced Digital Signal Processing: Theory and Applications”, John Wiley & Sons Ltd Publications, 1993.
4. S.V. Vaseghi, “Advanced Digital Signal Processing and Noise Reduction”, John Wiley & Sons Ltd Publications, 2006.

SPD503 Image Analysis and Processing

Introduction, Components of digital image processing system, Image sampling, Quantization and representation. Basic gray level transformation, Histogram processing, Basics of spatial filtering, Smoothing and sharpening spatial filters. Color fundamentals, Color models, Basics of full color image processing, Color transformations, Smoothing and sharpening. Basics of filtering in frequency domain, Smoothing and sharpening frequency domain filters. Image degradation/restoration Process, Noise models, Restoration in presence of noise, Inverse filtering, Minimum mean square filtering, Geometric mean filter. Image Compression Fundamentals, Spatial and temporal redundancy, Measuring image information, Image compression methods, Loss less compression, Lossy compression. Image Segmentation Fundamentals, Point, line and edge detection, Edge linking and boundary detection, Thresholding, Region based segmentation. Introduction to morphological image processing operations, dilation and erosion, opening and closing, hit-or-miss transformation, boundary extraction, region filling, extraction connected components, convex hull, thinning, thickening, skeletons, pruning. Representation, Description and Recognition, chain codes, polygonal approximation and skeletons, Boundary descriptors-simple descriptors, shape numbers, Regional descriptors- simple, topological descriptors, Pattern and Pattern Classes-Recognition based on matching techniques and neural networks.

Suggested Books:

1. R.C. Gonzalez and R.E. Woods, “Digital Image Processing”, Pearson Education, 2018.

2. A.K. Jain, "Fundamentals of Digital Image Processing", Pearson Education, PHI, 2001.
3. R.C. Gonzalez, R.E. Woods and Eddins, "Digital Image Processing using MATLAB", McGraw Hill, 2013
4. J.C. Russ and J.C. Russ, "Introduction to Image processing and analysis", CRC Press, 2017.
5. G. Georg and D. Patrice, "Image Processing and Analysis: A Primer", World Scientific Publishing Europe Ltd, 2018.
6. S. Birchfield, "Image Processing and Analysis", Cengage Learning, 2016.
7. K.R. Castleman, "Digital Image processing", Pearson Education, 2014.
8. I. Pitas, "Digital Image Processing Algorithms and Analysis", John Wiley, 2002.
9. M. Sonka, V. Hlavac and R. Boyle, "Image Processing, Analysis, and Machine Vision", Brookes/Cole, PWS Publishing Company, Thomson Learning, 2014.

SPD5401 Wireless communication

Introduction to Wireless Communications, the wireless channel (physical modeling, linear time-varying system, discrete- time baseband model, time and frequency coherence), Statistical Fading Models, Narrowband Models, Wideband Fading, Doppler and Delay Spread, Point to-point communication (detection, diversity), Capacity of Flat and Frequency Selective Fading Channels. Probability of Symbol Error, Combined Average Error and Outage. Diversity Techniques: Transmit Diversity and Receive Diversity, Maximal Ratio Combining and Beamforming. Cellular systems (multiple access, interference management), Multicarrier Modulation: Spread Spectrum, Intro to MIMO, OFDM and Massive-MIMO. Capacity of point-to-point wireless channels (single and multi-antenna), capacity of single-antenna multiuser channels, point-to-point multiantenna (MIMO) channels and spatial multiplexing, Point-to-point MIMO capacity and multiplexing architectures.

Suggested Books:

1. D. Tse and P. Viswanath, "Fundamentals of Wireless Communication", Cambridge University Press, 2005.
2. A.F. Molisch, "Wireless Communications", John Wiley & Sons. Copyright, 2012.
3. Rappaport, "Wireless Communications: Principles and Practice", Pearson Education Inc., 2010.
4. A. Goldsmith, "Wireless Communications", Cambridge University Press, 2005.

SPD5403 Advanced Digital System Design

Basics of Verilog; Introduction to finite state machine: pulse and fundamental mode of operation, realization of state table from verbal description, state diagram & Transition matrix, Mealy and Moore model machine. Reduction of flow tables of completely and incompletely specified sequential machines, concept of secondary state assignment and realization of circuits of FSM, Decomposition of FSM & composite machine equivalence between. Mealy and Moore model machine. Race and Hazard problems with asynchronous sequential machine stuck-at and bridging faults. Introduction to design with the programmable modules: ROM, PAL, PLA, FPGA, ASIC, Algorithmic state machine: ASM Chart, data and control subsystem and implementation of ASM. Introduction to ASM designing with microprogramming; Need for reliability, Faults as the sources of unreliability, Definitions of fault tolerance, fault tolerant attributes, fault classification, distribution models for permanent ,intermittent and transient faults ; Reliability Techniques: Information redundancy, hardware redundancy, and time redundancy. Basic approaches to hardware redundancy: Error masking, Dynamic redundancy, Hybrid hardware redundancy.

Suggested Books:

1. M.D. Ciletti, "Advanced Digital Design with the Verilog HDL", Pearson Education, 2011.

2. C. Unsalan and B. Tar, “Digital System Design with FPGA: Implementation Using Verilog and VHDL”, McGraw Hill Professional Publications, 2017.
3. L. Ngalamou, “Advanced Digital Systems Design with Rapid Prototyping on FPGAs using VHDL”, Springer Netherlands, 2019.

SPD5405 Analog Signal Processing

Translinear bipolar and MOS Circuits: General translinear principle, various translinear circuits ; MOS analog integrated circuits: Basic building blocks, differential amplifier pair, various current mirrors, active loads, level shifter etc. and complete NMOS op-amp; Low voltage analog signal processing: need of low-voltage signal processing, CMOS op-amp design, BiCMOS op-amp design; Current mode signal processing: current mode versus voltage mode signal processing, current conveyors, current feedback op-amp and their applications; Recent trends in analog signal processing: Realization of resistors in MOS technology, NMOS OTA, CMOS OTA, CMOS transconductor, OTRA, CDBA etc.

Suggested Books:

1. R.P. Areny and J.G. Webster, “Analog Signal Processing”, John Wiley & Sons, 2012.
2. E.T. Cuautle, “Integrated Circuits for Analog Signal Processing”, Springer Science & Business Media, 2012.
3. Y.K. Rybin, “Electronic Devices for Analog Signal Processing”, Springer, 2011.
4. P.B. Aronhime and F.W. Stephenson, “Analog Signal Processing”, Springer Science & Business Media, 2013.

SPD5407 Soft Computing

Neural Networks: History, overview of biological Neuro-system, Mathematical Models of Neurons, ANN architecture, Learning rules, Learning Paradigms- Supervised, Unsupervised and reinforcement Learning, ANN training Algorithms-perceptions, Training rules, Delta, Back Propagation Algorithm, Counter propagation network, architecture, functioning & characteristics of counter Propagation network, Hopfield/ Recurrent network, configuration, stability constraints, associative memory, and characteristics, limitations and applications. Hopfield v/s Boltzman machine, Adaptive Resonance Theory: Architecture, classifications, Implementation and training. Associative Memory, Fuzzy Logic: Introduction to Fuzzy Logic, Classical and Fuzzy Sets: Overview of Classical Sets, Membership Function, Fuzzy rule generation. Operations on Fuzzy Sets: Compliment, Intersections, Unions, Combinations of Operations, Aggregation Operations. Fuzzy Arithmetic: Fuzzy Numbers, Linguistic Variables, Arithmetic Operations on Intervals & Numbers, Lattice of Fuzzy Numbers, Fuzzy Equations. Fuzzy Logic: Classical Logic, Multi valued Logics, Fuzzy Propositions, Fuzzy Qualifiers, Linguistic Hedges. Uncertainty based Information: Information & Uncertainty, Non-specificity of Fuzzy & Crisp Sets, Fuzziness of Fuzzy Sets. Introduction of Neuro-Fuzzy Systems, Architecture of Neuro Fuzzy Networks, Rough Fuzzy Sets. Application of Fuzzy Logic: Medicine, Economics etc. Genetic Algorithm: An Overview, GA in problem solving, Implementation of GA Neuro-Genetic training of Backpropagation, Design and development of certain scientific and commercial application using computational neural network models, fuzzy models, fuzzy clustering applications and genetic algorithms in specified applications.

Suggested Books:

1. J.A. Anderson, “An Introduction to Neural Networks”, PHI, MIT Press, 1995.

2. J. Hertz, A. Krogh, R.G. Palmer and A. Wesley, "Introduction to the Theory of Neural Computation", California, CRC Press, 1991.
3. G.J. Klir and B. Yuan, "Fuzzy Sets & Fuzzy Logic: Theory and Applications", PHI, Pearson Education, 2009.
4. M. Mitchell, "An Introduction to Genetic Algorithm", PHI, MIT Press, 1998.

SPD5301 Digital Watermarking

Digital Watermarking: Basics, Models of Watermarking, Basic Message Coding, Error Correction Coding; Digital Watermarking: Theoretic Aspects, Mutual Information and Channel Capacity. How to Design a Good Digital Watermark, Information Theoretical Analysis of Digital Watermarking; Digital Watermarking Schemes (I), Spread Spectrum Watermarking, DCT-Domain Watermarking Digital Watermarking Schemes (II), Quantization Watermarking; Digital Watermarking: Protocol, A Buyer-Seller Watermarking Protocol, An Efficient and Anonymous Buyer-Seller Watermarking Protocol, Media-Specific Digital Watermarking, Video Watermarking, Audio Watermarking, Binary-Image Watermarking; Advanced Digital Watermarking, Watermarking with Side Information, Improved Spread Spectrum, Robustness to Temporal and Geometric Distortions, Affine-Resistant Watermarking, Wavelets and its application to watermarking, Non-Linear Optimization and its application to watermarking

Suggested Books:

1. F.Y. Shih, "Digital Watermarking and Steganography: Fundamentals and Techniques", CRC Press, Taylor & Francis Group, 2017.
2. I. Cox, M. Miller, J. Bloom, J. Fridrich and T. Kalker, "Digital Watermarking and Steganography", ELSEVIER, Morgan Kaufmann Publishers, 2007.
3. A.K. Singh, B. Kumar, G. Singh and A. Mohan, "Medical Image Watermarking: Techniques and Applications", Springer, 2017.

SPD5303 Wavelets in Signal Processing

Limitations of Fourier Transform (FT), Short Time Fourier Transform (STFT), Time-frequency representation in STFT, Effects of window on frequency and time resolution, Limitations of STFT. Introduction to wavelets, Continuous wavelet transform (CWT), Essential and desirable properties of mother wavelet function, Translation and scaling parameters. Discrete wavelet transforms. One level and multi-level transformation, Filter analysis and filter banks, Approximation and detail coefficients. Limitations of DWT. Haar wavelet, Daubechies wavelet, Gaussian wavelet, Biorthogonal wavelet, Coiflets wavelet, Symlets wavelet, Morlet wavelet, Maxican Hat wavelet, Meyer wavelet and other wavelets. Applications of thresholding techniques in DWT, Different types of thresholding techniques. Complex wavelet transforms (CWT), Dual-tree wavelet transforms (DTWT) and Dual-tree complex wavelet transform (DTCWT). Stationary wavelet transforms (SWT). Applications of wavelet transforms in field of biomedical signal and image processing. Latest trends in field of biomedical signal and image processing using wavelet transforms.

Suggested Books:

1. S. Mallat, "A Wavelet Tour of Signal Processing", Elsevier, 1999.

2. M. Weeks, "Digital Signal Processing Using MATLAB & Wavelets", Jones & Bartlett Publishers, 2011.
3. H.G. Stark, "Wavelets and Signal Processing: An Application-Based Introduction", Springer Science & Business Media, 2005.
4. A. Teolis, "Computational Signal Processing with Wavelets", Birkhäuser Publisher, 2017.

SPD5305 Advanced Computer Architecture

The state of Computing, Multiprocessors and Multicomputers, Multivector and SIMD Computers, PRAM and VLSI Models. Conditions of Parallelism, Program Partitioning and Scheduling, Program Flow Mechanism, System Interconnect Architecture. Advanced Processor Technology, Superscalar and vector Processors, Memory Hierarchy Technology, Virtual Memory Technology. Backplane Bus Systems, Cache Memory Organizations, Shared-Memory Organizations, Sequential and Weak Consistency Models. Linear Pipeline Processors, Nonlinear Pipeline Processors, Instruction Pipeline Design, Arithmetic Pipeline Design, Superscalar and Superpipeline Design. Multiprocessor System Interconnects Cache Coherence and Synchronization Mechanisms, Message-Passing Mechanisms. Vector Processing principles, Multivector Multiprocessors, Compound Vector Processing, Principles of Multithreading, Dataflow and Hybrid Architectures.

Suggested Books

1. K. Hwang and N. Jotwani, "Advanced Computer Architecture", McGraw Hill Education, 2016.
2. M.J. Flynn, "Computer Architecture: Pipelined and Parallel Processor Design", Jones and Barlett, Boston, 1995.
3. R. Chopra, "Advanced Computer Architecture", S. Chand Publishing, 2008.
4. S.G. Shiva, "Advanced Computer Architectures", CRC Press, 2018.
5. J.P. Hayes, "Computer Architecture and Organization", McGraw Hill, 1988.

SPD5307 Network Security & Cryptography

Security in Computing Environment: Need for Security, Security Attack, Security Services, Information Security, Methods of Protection. Planning and Enforcing Security Policies: Planning Security Policies, Risk Analysis, Security Policies for an Organization; Basics of Cryptography: Terminologies used in Cryptography, Substitution Techniques, Transposition Techniques. Encryption and Decryption: Characteristics of Good Encryption Technique, Properties of Trustworthy Encryption Systems, Types of Encryption Systems, Confusion and Diffusion, Cryptanalysis; Symmetric Key Encryption: Data Encryption Standard (DES) Algorithm, Double and Triple DES, Security of the DES, Advanced Encryption Standard (AES) Algorithm, DES and AES Comparison. Public Key Encryption: Characteristics of Public Key System, RSA Technique, Key Exchange, Diffie-Hellman Scheme, Cryptographic Hash Functions, Digital Signature, Certificates, Certificate Authorities; Protection of Computing Resources: Secure Programs, Non-malicious Program Errors, Viruses and Other Malicious Code, Targeted Malicious Code, Methods of Control. Security Features in Operating System: Objects to be Protected, Protection Methods of Operating Systems, Memory Protection, File Protection, User Authentication; Network Security: Network Concepts, Threats in Networks, Network Security Controls. IP Security: Overview of IP Security (IPSec), IP Security Architecture, Modes of Operation, Security Associations (SA), Authentication Header (AH), Encapsulating Security Payload (ESP), Internet Key Exchange. Web Security: Web Security Requirements, Secure Socket Layer (SSL), Transport Layer Security (TLS), Secure Electronic Transaction (SET).

Suggested Books:

1. M. Kumar, "Cryptography and Network Security", Krishna Prakashan Media, 2012.
2. S.M. Musa, "Network Security and Cryptography", Mercury Learning and Information, 2018.
3. A. Kahate, "Cryptography and Network Security", Tata McGraw Hill Education, 2013.
4. B.A. Forouzan and D. Mukhopadhyay, "Cryptography and Network Security", McGraw Hill Education, 2011.

SPD5201 SEMINAR

SPD5203 Language Lab

Organs of Speech, Speech Sounds, Phonetic symbols, Place of Articulation, Manner of Articulation, Stress, Syllable, Transcription of words and, short Sentences, Voiced and Voiceless Sounds Dialogues- Principles and Characteristics, Mock Interviews - Do's and Don'ts, Group Discussion - Truth Taking Strategy, Presentations and Debates - Essentials of Oral Presentations, Nature of Basic Topics, Rules.

Suggested Books:

1. E.S. Kumar and P. Sreehari, "A Handbook for English Language Laboratories", Cambridge University Press, 2007.
2. D.S. Rani, "A Manual for English Language Laboratory", Pearson Education India, 2010.
3. N. Konar, "English Language Laboratories: A Comprehensive Manual", PHI Learning Pvt. Ltd, 2011.

SPD5205 Statistical Signal Processing

Probability; Introduction, Spinning pointers and flipping coins, Probability spaces, Discrete probability spaces, Continuous probability spaces, Independence, Elementary conditional probability; Random variables, vectors, and processes, Distributions of random variables, Random vectors and random processes, Distributions of random vectors, Independent random variables, Conditional distributions, Statistical detection and classification, Additive noise, Binary detection in Gaussian noise, Statistical estimation, Characteristic functions, Gaussian random vectors, Simple random processes, Directly given random processes, Discrete time Markov processes, nonelementary conditional probability; Expectation and averages, Functions of random variables, Functions of several random variables, Properties of expectation, Conditional expectation, Jointly Gaussian vectors, Expectation as estimation, Implications for linear estimation, Correlation and linear estimation, Correlation and covariance functions, the central limit theorem, Sample averages, Convergence of random variables, Weak law of large numbers, strong law of large numbers, Stationarity, Asymptotically uncorrelated processes; Second-order theory; Linear filtering of random processes, Linear systems I/O relations, Power spectral densities, Linearly filtered uncorrelated processes, Linear modulation, White noise, Time averages, Mean square calculus, linear estimation and filtering, a menagerie of processes, Discrete time linear models, Sums of iid random variables, Independent stationary increment; Second-order moments of isi processes, Specification of continuous time isi processes, Moving-average and autoregressive processes, The discrete time Gauss–Markov process, Gaussian random processes, The Poisson counting process, Compound processes, Composite random processes, Exponential modulation, thermal noise, Ergodicity, Random fields.

Suggested Books:

1. R.M. Gray and L.D. Davisson, "An Introduction to Statistical Signal Processing", Cambridge University Press, 2004.
2. Kay, "Fundamentals of Statistical Processing, Volume 2: Detection Theory", Pearson Education India, 2009.
3. P.J. Schreier and L.L. Scharf, "Statistical Signal Processing of Complex-Valued Data: The Theory of Improper and Noncircular Signals", Cambridge University Press, 2010.
4. U. Spagnolini, "Statistical Signal Processing in Engineering", John Wiley & Sons, 2018.

SPD5207 Wireless sensor networks

Adhoc Networks: Introduction. Routing protocols: proactive and reactive methods, backbone and position based, and power efficient routing. Introduction and applications. Design issues and architecture of Sensor Networks. Issues and challenges, Self-organization, Localization of sensor deployment. Tree construction algorithms and analysis, Asymptotic capacity, - Lifetime optimization formulations related to Data Fusion Routing protocols: data centric, hierarchical, location based, energy efficient routing etc. Querying, data collection and processing.

Suggested Books:

1. J. Zheng and Abbas Jamalipour, "Wireless Sensor Networks: A Networking Perspective", John Wiley & Sons, 2009.
2. I.M.M.E. Emary and S. Ramakrishnan, "Wireless Sensor Networks: From Theory to Applications", CRC Press, 2013.
3. W. Dargie and C. Poellabauer, "Fundamentals of Wireless Sensor Networks: Theory and Practice", John Wiley & Sons, 2010.
4. F. Zhao, L.J. Guibas and L. Guibas, "Wireless Sensor Networks: An Information Processing Approach", Morgan Kaufmann Publishers, 2004.

SPD5209 Real Time Operating Systems

Introduction. Modeling Timing constraints, Scheduling Real-Time Tasks: Types of Schedulers, table-driven, Cyclic, EDF, RMA. Handling Resource sharing among real-time tasks. Scheduling Real-Time Tasks in Multiprocessor and Distributed systems. Commercial Real-time operating systems: General concepts, Unix and Windows as RTOS. Survey of commercial RTOS. Real-Time Communication. Real-Time Databases.

Suggested Books:

1. "Real-Time Operating Systems", University-Press Org, 2013.
2. Research Papers

SEMESTER II

SPD502 Pattern Analysis and Machine Intelligence

Supervised learning (generative/discriminative learning, parametric/nonparametric learning, neural networks, and support vector machines); unsupervised learning (clustering, dimensionality reduction, kernel methods); learning theory (bias/variance tradeoffs; VC theory; large margins); Reinforcement learning and adaptive control; - Discriminant Functions and Services-the Normal

Distribution, Bayesian Classification, Estimating Probability Density Functions, Nearest Neighbor Rules, Bayesian Networks, Linear Classifiers, the Perceptron Algorithm, Least-Squares Methods, Nonlinear Classifiers, Multilayer Perceptron's, Back Propagation Algorithm, Decision Trees, Combinations of Classifiers, Boosting, Feature Selection, Data Preprocessing, ROC Curves, Class Separability Measures, Feature Subset Selection, Bayesian Information Criterion, Dimensionality Reduction,- Basis Vectors, Singular Value Decomposition, Independent Component Analysis, Kernel PCA, Gaussian mixture model. Clustering- Sequential Algorithms, Hierarchical Algorithms, Functional Optimization-Based Clustering, Graph Clustering, Learning Clustering, Clustering High Dimensional Data, Subspace Clustering, Cluster Validity Measures, Reinforcement learning, single state case, k-armed bandit, elements of reinforcement learning.

Suggested Books

1. C.M. Bishop, "Pattern Recognition and Machine Learning", Springer New York, 2016.
2. C.M. Bishop, "Neural Networks for Pattern Recognition", Oxford University Press, 1995.
3. R. O. Duda, P. Hart and D. Stork, "Pattern Classification", Wiley, 2012.

SPD504 Embedded System

Overview of Embedded Systems: Characteristics of Embedded Systems. Comparison of Embedded Systems with general purpose processors. General architecture and functioning of PIC micro controller. Architecture, memory interfacing, interrupts, instructions, programming and peripherals. ARM: Architecture, memory interfacing, interrupts, instructions and Assembly Language programming. Exception processing and pipeline architecture and applications. Variants of ARM architecture Digital Signal Processors: DSP Architecture, DSP applications, algorithms, data path, memory, addressing modes, peripherals. TI and Sharc family of DSP processors. System On Chip: Evolution, features, IP based design, TI OMAP architecture and peripherals. Digital Multimedia processor: Architecture and peripherals. RTOS: RT-Linux introduction, RTOS kernel, Real-Time Scheduling Bus structure: Time multiplexing, serial, parallel communication bus structure. Bus arbitration, DMA, PCI, AMBA, I2C and SPI Buses.

Suggested Books

1. W. Wolf, "Computers as components: Principles of Embedded Computing System Design", Morgan Kaufman Publication, 2008.
2. A.N. Sloss, D. Symes and C. Wright, "ARM System Developer's Guide: Designing and Optimizing System Software", Morgan Kaufman Publication, 2004.
3. J.B. Peatman, "Design with PIC Microcontrollers", Pearson Education Asia, 2003.
4. T. Wilmshurst, "The Design of Small-Scale embedded systems", Palgrav, 2001.
5. P. Marwedel, "Embedded System Design", Kluwer Publishers, 2006.

SPD5402 Computer Vision

Camera geometry, camera calibration, vanishing points ;Computational tools for creating Image Panoramas: homographies, RANSAC for point-matching, SIFT (scale invariant feature transform) for detection of salient feature points ;Algorithms for - shape from shading, depth from needle map; optical flow, Kanade-Lucas-Tomasi algorithm, applications of optical flow in underwater imagery; shape from stereo, epipolar geometry; structure from motion; Photometric stereo - deriving shape from

multiple images of an object taken under different lighting conditions; applications to illumination invariant face recognition, face relighting ;Machine Learning in computer vision: Face detection using Adaboost, Object detection using parts ;Some topics in computational photography/ more topics in machine learning based computer vision ;Some of the above topics will make use of concepts from signal processing (Fourier transform, convolution) and linear algebra (principal components analysis (PCA) and singular value decomposition (SVD))

Suggested Books:

1. D. A. Forsyth and J. Ponce, "Computer Vision: A Modern Approach", Prentice Hall, 2015.
2. L.G. Shapiro and G.C. Stockman, "Computer Vision", Prentice-Hall, 2001.
3. B.K.P. Horn, "Robot Vision", McGraw-Hill., 1986
4. R. Hartley and A. Zisserman, "Multiple View Geometry in Computer Vision", Cambridge University Press, 2004.

SPD5404 IOT & Applications

Defining IoT, Characteristics of IoT, Physical design of IoT, Logical design of IoT, Functional blocks of IoT, Communication models & APIs. Machine to Machine, Difference between IoT and M2M. Wireless medium access issues, MAC protocol survey, Survey routing protocols, Sensor deployment & Node discovery, Data aggregation & dissemination. Home automation, Industry applications, Surveillance applications, Other IoT applications. Design challenges, Development challenges, Security challenges.

Suggested Books

1. V. Tsiatsis, S. Karnouskos, J. Holler, D. Boyle and Catherine Mulligan, "Internet of Things: Technologies and Applications for a New Age of Intelligence", Academic Press, 2018.
2. B.K. Tripathy and J. Anuradha, "Internet of Things (IoT): Technologies, Applications, Challenges and Solutions", CRC Press, 2017.
3. V. Madiseti and A. Bahga, "Internet of Things: A Hands-On Approach", 2014.
4. W. Dargie and C. Poellabauer, "Fundamentals of Wireless Sensor Networks: Theory and Practice", John Wiley & Sons, 2011.
5. A. McEwen and H. Cassimally, "Designing the Internet of Things", John Wiley & Sons, 2014.
6. O. Vermesan and P. Friess, "Internet of Things: Converging Technologies for Smart Environments and Integrated Ecosystems", River Publishers, 2013.

SPD5406 Speech Processing

Speech signal: production, perception, acoustic- phonetic characterization, signal processing methods for speech recognition, pattern- comparison techniques, speech recognition system design and implementation issues, speech recognition based on connected word models, task oriented applications of automatic speech recognition.

Suggested Books:

1. L. Rabiner, L.R. Rabiner and B.H. Juang, "Fundamentals of Speech Recognition", Prentice-Hall, 1993.

2. J. Benesty, M.M. Sondhi and Yiteng Huang, “Springer Handbook of Speech Processing”, Springer Science & Business Media, 2007.
3. L. Deng and D.O. Shaughnessy, “Speech Processing: A Dynamic and Optimization-Oriented Approach”, CRC Press, Marcel Dekker, Inc., 2003.
4. L.R. Rabiner and R.W. Schafer, “Introduction to Digital Speech Processing”, Now Publishers Inc., 2007.

SPD5408 Fractional Delay Filters

Simple Interpolators suitable for Real Time Fractional Delay Filtering, Linearly Interpolated Delay Line (1st-Order FIR), Allpass Interpolated Delay Line (1st-Order), Linear Interpolation, Frequency Responses of Linear Interpolation for Delays between 0 and 1, Linear Interpolation as a Convolution, Up sample, Shift, Down sample View, First-Order Allpass Interpolation, Phase Delays of First-Order Allpass Interpolators for Various Desired Delays; Interpolation Overview, Well Known Closed-Form Solutions, Ideal Bandlimited (Sinc) Interpolation, The Sinc Function (Cardinal Sine), Applications of Bandlimited Interpolation, Ideal D/A Conversion, Ideal D/A Example, Optimal Least Squares Bandlimited Interpolation Formulated as a Fractional Delay Filter, Truncated-Sinc Interpolation, Windowed Sinc Interpolation, Lowpass Filter Design; Interpolator Types, Lagrange Interpolation, Example Lagrange Basis Functions, Lagrange Interpolation Optimality, Proof of Maximum Flatness at DC, Lagrange Interpolator Amplitude Responses, Lagrange Interpolator Phase Delays, Orders 1-5, Amplitude Response of Fractional Delays, Phase Delay Over a Range of Fractional Delays, Amplitude Response Over a Range of Fractional Delays, Lagrange Interpolation Coefficients; Implementation: Lagrange Interpolation to Windowed Sinc, Variable FIR Interpolating Filter, Farrow Structure for Variable Delay FIR Filters, Thiran Allpass Interpolators, Frequency Responses of Thiran Allpass Interpolators for Fractional Delay, Large Delay Generation, L-Infinity, Chebyshev) Fractional Delay Filters, Chebyshev FD-FIR Design. Latest two research papers to be discussed and implemented.

Suggested Books:

1. T. Michalowski, “Applications of MATLAB in Science and Engineering”, BoD – Books on Demand, 2011.
2. U.M. Baese, “Digital Signal Processing with Field Programmable Gate Arrays”, Springer Science & Business Media, 2013.

SPD5302 MINOR PROJECT

SPD5304 Biomedical Signal Modelling

Introduction to biomedical signals: Bio-chemical, Bio-electrical and Bio-mechanical signals; ECG: Waveform, different intervals and segments, ECG data acquisition, ECG lead systems, ECG parameters and their estimation, different types of artifacts and their effect on ECG waveform; EEG: Waveform, different frequency sub-bands, different types of EEG, different EEG measuring methods, different types of artifacts and their effect on EEG. Different types of EEG artifacts. Patient-related (physiological) artifacts and system artifacts; Modelling of Power line interference, Baseline wander artifact, Electrode contact & motion artifact and Instrumentation noise. Modelling of Electro-Myogram (EMG), ECG or pulsation, Electro-Oculogram (EOG) or Ocular artifact and Ballistocardiogram; Imaging Modalities: Survey of major modalities for medical imaging: ultrasound, X-ray, CT, MRI, PET and SPECT. MRI: Physics and signal processing for magnetic resonance imaging; Different types of MRI features and feature enhancement methods.

Suggested Books:

1. S. Cerutti and C. Marchesi, "Advance Methods of Biomedical Signal Processing", John Wiley & Sons, 2011.
2. J.L Semmlow, "Biosignal and Biomedical image processing: MATLAB based applications", Marcel Dekker Inc., 2004.
3. R.C. Gonzalez and R.E. Woods, "Digital Image Processing using MATLAB", Pearson Education International, 2017.

SPD5306 Object Tracking

Image-Based Object Tracking, Introduction, Methodologies, Background Subtraction, Temporal Difference between Frames Correlation-Based Tracking, Colour-Based Tracking, Algorithmic Account; Face Recognition, Face Recognition Approaches, Vector Representation of Images, Process Details, Algorithmic Account; Soft Computing in Image Processing, Fuzzy Logic in Image Processing, Algorithmic Account , Image Compression, Image Compression–Decompression Steps, Classifying Image Data ,Bit Allocation, Quantization, Entropy Coding, JPEG Compression, Algorithmic Account; Edge Detection, Sobel Operator, the Prewitt Operator, the Canny Operator, The Compass Operator (Edge Template Matching), The Zero-Crossing Detector, Line Detection , The Unsharp Filter, Algorithmic Account.

Suggested Books:

1. J. Hertz, A. Krogh and R.G. Palmer and A. Wesley, "Introduction to the Theory of Neural Computation", California, CRC Press, 1991.
2. G.J. Klir and B. Yuan, "Fuzzy Sets & Fuzzy Logic: Theory and Applications", PHI, Pearson Education, 2009.
3. M. Grinberg, "Feature-Based Probabilistic Data Association for Video-Based Multi-Object Tracking", KIT Scientific Publishing, 2018.
4. Stan Z. Li and Anil K. Jain, "Handbook of Face Recognition", Springer Science & Business Media, 2005.
5. C.I. Gonzalez, P. Melin, J.R. Castro and O. Castillo, "Edge Detection Methods Based on Generalized Type-2 Fuzzy Logic", Springer, 2017.

SPD5308 Optimization Techniques

Mathematical preliminaries, Linear algebra and matrices, Vector space, eigen analysis, Elements of probability theory, Elementary multivariable calculus; Introduction to linear programming model, Simplex method, Duality, Karmarkar's method; One-dimensional search methods, Gradient-based methods, Conjugate direction and quasi-Newton methods; Lagrange theorem, FONC, SONC, and SOSC conditions; Non-linear constrained optimization models, KKT conditions, Projection methods.

Suggested Books:

1. C.A. Floudas and P.M. Pardalos, "Encyclopedia of Optimization", Springer Science and Business Media, 2001.
2. S. Theodoridis, "Machine Learning: A Bayesian and Optimization Perspective", Academic Press, 2015.
3. X.S. Yang, "Optimization Techniques and Applications with Examples", John Wiley and Sons, 2018.
4. C.B. Gupta, "Optimization Techniques in Operation Research", I.K International Pvt Ltd, 2008.

SPD5310 Artificial Intelligence

AI Problems, Task Domains of AI, Introduction to Intelligent program and intelligent methodologies. Search knowledge, abstraction, Basic Problem solving Method: state space search, problem characteristics, Production systems characteristics, issues in design of Intelligent search algorithm, Hill climbing techniques, Best First search, A* Search, AO* Search, Constraint Satisfaction, Means-End Analysis, Game Tree, Searching procedure Minimax, alpha-beta Pruning, Knowledge Representation issues, Predicate Logic: Unification, resolution, Natural deduction, Forward versus backward reasoning, conflict resolution, Semantic Nets, Frames, conceptual dependency, scripts, Prolog or Lisp implementation of inferences for above knowledge representation methods, Introduction to Non-Monotonic Reasoning, Logics for non-monotonic reasoning such as Default reasoning; Minimalist reasoning; implementation issues, Probabilistic Reasoning, Certainty Factors and Rule Based Reasoning, Bayesian Network, Dempster Shafer Theory, Fuzzy logic, Concept of learning, learning in problem solving, learning by inductions, genetic algorithm, Neural Network, Genetic theorem and machine Learning Applications, Expert Systems Architecture, Domain Knowledge, Knowledge Acquisition, Case Studies: MYCIN, RI, Natural language Processing: Syntactic, Semantic and Pragmatic Analysis, Research issues in different domains.

Suggested Books:

1. E. Rich and K. Knight, "Artificial Intelligence", McGrawHill, 2004.
2. E. Alpaydin, "Introduction to Machine Learning", MIT Press, 2004
3. T. Mitchell, "Machine Learning", McGraw Hill, 1997
4. P. Langley, "Elements of Machine Learning", Morgan Kaufmann Publishers, Inc., 1995.

SPD5312 Reconfigurable Computing

Introduction to Reconfigurable Computing, FPGA Architectures, FPGA Design Cycle, Technology-independent optimization, Technology Mapping, Placement, Routing, Coarse-grained Reconfigurable Devices, Multi-FPGA Systems, Reconfigurable Computing Applications, Molecular Dynamics, Image processing, Video processing, Bioinformatics, Cryptography, Fault tolerant systems, FPGAs vs. Multicore architectures, Advanced Topics: Dynamic Reconfiguration, Partial Reconfiguration

Suggested Books:

1. S. Hauck and A. DeHon, "Reconfigurable Computing: The Theory and Practice of FPGA-Based Computation", Elsevier, 2010.
2. C. Bobda, "Introduction to Reconfigurable Computing: Architectures, Algorithms, and Applications", Springer Science & Business Media, 2007.
3. J. Cardoso and M. Hübner, "Reconfigurable Computing: From FPGAs to Hardware/Software Codesign", Springer Science & Business Media, 2011.
4. M.B. Gokhale and P.S. Graham, "Reconfigurable Computing: Accelerating Computation with Field-Programmable Gate Arrays", Springer Science & Business Media, 2006.
5. N. Nedjah and C. Wang, "Reconfigurable and Adaptive Computing: Theory and Applications", CRC Press, 2018.

SPD5202 Research Methodology & Report writing

Research Concept, basis and nature of inquiry and research, Types of Scientific Research and Falsification critical thinking, Introduction to Research, Need, Ethics, Research Plan, Literature Review, Citation, Plagiarism, Report structure and Writing, Hypothesis, Modeling, Data collection, Tests of Hypothesis, Validation, Literature Review – Longitudinal and thematic, Nature of data – primary, secondary, Techniques of measurement & Scaling, sampling methods, Sample design, Collection of data – research questionnaire, survey methods, Research design – Exploratory, Experimental, Causal, Analytical, Empirical, Case research.

Suggested Books:

1. Krishnaswamy, “Management Research Methodology: Integration of Principles, Methods and Techniques”, Pearson Education India, 2011.
2. G.T. Wang and K. Park, “Student Research and Report Writing: From Topic Selection to the Complete Paper”, John Wiley & Sons, 2016.
3. C. R. Kothari, “Research Methodology: Methods and Techniques”, New Age International, 2004.

SPD5208 VLSI Signal Processing Architecture

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. Pipelining and Parallel Processing: Pipelining and parallel processing of FIR digital filters, pipeline interleaving in digital filters: signal and multichannel interleaving. Retiming, Unfolding and Folding: retiming techniques; algorithm for unfolding, Folding transformation, systolic architecture design, systolic array design methodology. Fast Convolution, Filters and Transforms: Cook-toom algorithm, modified cooktoom algorithm, winogard algorithm, iterated convolution Algorithm strength reduction in filters and transforms.

Suggested Books

1. V. Madiseti, “VLSI Digital Signal Processors: An Introduction to Rapid Prototyping and Design Synthesis”, IEEE Press, 1995.
2. M.A. Bayoumi, “VLSI Design Methodologies for Digital Signal Processing Architectures”, Springer Science & Business Media, 2012.
3. H.J.R. Liu and K. Yao, “High-Performance VLSI Signal Processing Innovative Architectures and Algorithms, Algorithms and Architectures”, Wiley, 1998.
4. K.K. Parhi, “VLSI Digital Signal Processing Systems: Design and Implementation”, John Wiley & Sons, 2007.

SEMESTER III

SPD6401 Multispectral signal Analysis

Hyperspectral Sensors and Applications: Introduction, Multi-spectral Scanning Systems (MSS), Hyperspectral Systems, Airborne sensors, Spaceborne sensors, Ground Spectroscopy, Software for Hyperspectral Processing, Applications, Atmosphere and Hydrosphere, Vegetation, Soils and Geology, Environmental Hazards and Anthropogenic Activity; Mutual Information: A Similarity Measure for Intensity Based Image Registration, Introduction, Mutual Information Similarity Measure, Joint Histogram Estimation Methods, Two-Step Joint Histogram Estimation, One-Step Joint Histogram Estimation, Interpolation Induced Artifacts, Generalized Partial Volume Estimation of Joint Histograms, Optimization Issues in the Maximization of MI; Independent Component Analysis: Introduction, Concept of ICA, ICA Algorithms, Preprocessing using PCA, Information Minimization Solution for ICA, ICA Solution through Non-Gaussianity Maximization, Application of ICA to Hyperspectral Imagery, Feature Extraction Based Model, Linear Mixture Model Based Model, An ICA algorithm for Hyperspectral Image Processing, Applications using ICA; Markov Random Field Models: Introduction, MRF and Gibbs Distribution, Random Field and Neighborhood, Cliques, Potential and Gibbs Distributions

Suggested Books:

1. D.A. Landgrebe, "Signal Theory Methods in Multispectral Remote Sensing", John Wiley and Sons, 2005.
2. C.I. Chang, "Hyperspectral Data Processing: Algorithm Design and Analysis", John Wiley and Sons, 2013.
3. C. Ünsalan and K.L. Boyer, "Multispectral Satellite Image Understanding", Springer Science & Business Media, 2011.

SPD6403 Testing and Diagnosis of Digital system design

Faults in digital circuits: Fault modelling, fault detection, redundancy, equivalence, fault dominance ; Stuck at faults, bridging faults, stuck open faults, transient faults, permanent faults; Test generation for combinational circuits : Path sensitization, boolean difference, D algorithm, PODEM; Testing of sequential circuits : state identification experiments, checking experiments and machine identification; Checking circuits & self checking , totally self-checking : m/n code self-checkers and equality self checkers. Self-checking in PLAs; Design for testability: controllability and observability, random test generation, transition count testing, signature analysis, syndrome testable design, level sensitive scan design, BIST: LSSD on chip self-test, BILBO, BIDCO, Boundary scan standard; Fault detection in RAM and microprocessors.

Suggested Books:

1. Z. Navabi, "Digital System Test and Testable Design: Using HDL Models and Architectures", Springer Science & Business Media, 2010.
2. P.K. Lala, "An Introduction to Logic Circuit Testing", Morgan & Claypool Publishers, 2009.
3. P.K. Lala, "Digital Circuit Testing and Testability", Academic Press 1997.
4. N.K. Jha and S. Gupta, "Testing of Digital Systems", Cambridge University Press, 2003.

SPD6405 Detection and estimation theory

Introduction of random process, Detection of signals – estimation of signal parameters, Detection and estimation in white Gaussian noise, Detection and estimation in non-white Gaussian noise. Linear estimation. Bayesian Detectors, Minimum Variance Unbiased Estimators, Maximum Likelihood Estimators, Cramer-Rao Lower Bounds, Bayesian Estimators, Minimum Mean Squared Error Estimators, Least Squares Estimators, Linear Prediction. Applications in communications and sensor networks.

Suggested Books:

1. H.V. Poor, "An Introduction to Signal Detection and Estimation", Springer Science and Business Media, 2013.
2. H.L.V. Trees, "Detection, Estimation, and Modulation Theory, Part I", John Wiley and Sons, 2004.

SPD6407 Digital Design and verification

MOS Transistors structure and operation of MOS transistor, MOS system under external Bias, Threshold voltage, MOSFET device design equation, MOSFET scaling, MOSFET capacitances. MOS Inverters static characteristics: Introduction, Resistive-Load Inverter, Inverters with n-type MOSFET load, CMOS Inverter. Switching characteristics, Inverter design with Delay constraints, Switching Power Dissipation of CMOS Inverters. Combinational MOS Logic Circuits: MOS logic circuit with depletion nMOS Loads, CMOS logic circuits, Complex Logic circuits, CMOS Transmission Gates. Sequential MOS Logic Circuits: Behavior of bistable elements, SR latch, Clocked latch and flip-flop, CMOS D latch and flip-flop. MOS Circuit Design Processes, MOS Layers, Stick Diagrams, Design Rule and Layout. CMOS Basic Circuits Layout Design: NAND, NOR, AND, OR, AOI circuits. Introduction to Hardware Verification and methodologies, Binary Decision Diagrams (BDDs) and algorithms over BDDs, Combinational equivalence checking, Temporal Logics, Modeling sequential systems and model checking, Symbolic model checking.

Suggested Books:

1. D.L. Perry and H. Foster, "Applied Formal Verification: For Digital Circuit Design", McGraw Hill Professional, 2005.
2. W.K. Lam, "Hardware Design Verification: Simulation and Formal Method-based Approaches", Prentice Hall PTR, 2005.

Elective 8

SPD6301 Data Analytics

Descriptive Statistics, Introduction to the course Descriptive Statistics Probability Distributions, Inferential Statistics through hypothesis tests Permutation & Randomization Test, Regression and ANalysis of variance (ANOVA), Introduction to Machine Learning Concepts, Differentiating algorithmic and model based frameworks, Ordinary Least Squares, Ridge Regression, Lasso Regression, K Nearest Neighbours Regression & Classification, Bias-Variance Dichotomy, Knowledge of probability theory, statistics, and programming is desirable, Model Validation Approaches Logistic Regression Linear Discriminant Analysis: Quadratic Discriminant Analysis Regression and Classification Trees Support Vector Machines, Ensemble Methods: Random Forest Neural Networks Deep learning, Clustering Associative Rule Mining Challenges for big data analytics, Prescriptive analytics

Suggested Books:

1. EMC Education Services, "Data Science and Big Data Analytics", John Wiley and Sons, 2015.
2. J.D. Kelleher, B.M. Namee and A.D. Arcy, "Fundamentals of Machine Learning for Predictive Data Analytics", MIT Press, 2015.

SPD6303 SOC Design testing and verification

System tradeoffs and evolution of ASIC Technology- System on chip concepts and methodology – SoC design issues –SoC challenges and components; SoC Design Flow – On-chip buses –Design process for hard cores –Soft and firm cores –Designing with hard cores, soft cores- Core and SoC design examples; Embedded memories –Simulation modes Specification of analog circuits – A to D converter –Phase- located, loops –High I/O; Core level validation –Test benches –SoC design validation – Co simulation –hardware/ Software co-verification, Case Study: Validation and test of systems on chip; SoC Test Issues – Testing of digital logic cores –Cores with boundary scan –Test methodology for design reuse– Testing of microprocessor cores – Built in self method–testing of embedded memories.

Suggested Books:

1. P. Rashinkar, P. Paterson and Leena Singh, “System-on-a-Chip Verification: Methodology and Techniques”, Springer Science & Business Media, 2007.
2. V. Taraate, “Advanced HDL Synthesis and SOC Prototyping: RTL Design Using Verilog”, Springer, 2018.
3. F. Nekoogar, “From ASICs to SOCs: A Practical Approach”, Prentice Hall Professional, 2003.

SPD6305 FPGA Based System Design

VHDL Introduction, Introduction to VLSI Design, Front End and Back End Design, Computer Aided Design Technology, VHDL description, modelling strategies, VHDL data types, operators, attributes, signals, variables. VHDL Modelling, Modelling of Combinational & Sequential Circuits: Behavioural, Data Flow and Structural Realization of Adders, Multipliers, Comparators, Flip Flops, Shift Register, Counter, parity generator, Generics. Programmable Modules for Digital circuit designing with programmable modules: ROM, PAL, PLA, ASIC, FPGA. ASIC and FPGA Families, Programmable Asics, Programmable ASIC Logic Cells And Programmable ASIC I/O Cells Anti fuse – static RAM – EPROM and EEPROM technology – PREP benchmarks –Actel ACT – Xilinx LCA – Altera FLEX – Altera MAX DC & AC inputs and outputs –Clock & Power inputs – Xilinx I/O blocks. FPGA partitioning – partitioning methods – floor planning – placement – physical design flow – global routing – detailed routing – special routing – circuit extraction – DRC.

Suggested Books:

1. W. Wolf, “FPGA Based System design”, Pearson Education, 2004.
2. V. Sklyarov, I. Skliarova, A. Barkalov and L. Titarenko, “Synthesis and Optimization of FPGA-Based Systems”, Springer Science and Business Media, 2014.
3. J.J.R. Andina, E.d.I.T. Aranz and M.D. Valdes, “FPGAs: Fundamentals, Advanced Features, and Applications in Industrial Electronics”, CRC Press, 2017.

SPD6307 Biomedical Signal & image processing

Empirical Mode Decomposition (EMD): Decomposition of signal into Intrinsic Mode Functions (IMF), Stopping Criterion, Limitations of EMD, Ensemble Empirical Mode Decomposition (EEMD), Limitations of EEMD, Complete Ensemble Empirical Mode Decomposition (CEEMD), Limitations of CEEMD, Applications of EMD, EEMD and CEEMD in field of biomedical signal processing; Morphological Functions: Erosion and Dilation operators, Closing and Opening functions, Structuring element and effect of structuring element of biomedical signal and image denoising. Applications of morphological functions in field of biomedical signal and image processing; Adaptive Filters: Block diagram and Principle of adaptive filter, Transfer function and

Optimization algorithms. Applications of adaptive filters in field of biomedical signal processing; Independent Component Analysis (ICA): Decomposition of signal into Independent Components (IC), Mixing Matrix. Applications of ICA in field of biomedical signal and image processing. Limitations of ICA; Modifications in ICA: Wavelet Enhanced Independent Component Analysis (wICA), Specially Constraint Independent Component Analysis (SCICA), Selection of prior constraints, Mixing matrix modification. Applications of wICA and SCICA in field of biomedical signal and image processing; Image segmentation, Different image segmentation methods, Application of FCM and its variants for image segmentation, Active contour models or Snakes, internal and external energies in active contours, level set model, Integration of level sets with active contour models, Two-Phase Level Set Formulation, Multi-Phase Level Set Formulation, Distance Regularized Level Set Evolution.

Suggested Books:

1. S. Cerutti and C. Marchesi, "Advance Methods of Biomedical Signal Processing", John Wiley & Sons, 2011.
2. J.L Semmlow, "Biosignal and Biomedical image processing: MATLAB based applications", Marcel Dekker Inc., 2004.
3. R.C. Gonzalez and R.E., "Woods Digital Image Processing using MATLAB", Pearson Education International, 2017.

SPD6201 Operation Research

Introduction, Historical Background, Scope of Operations Research, Features of Operations Research, Types of Operations Research Models, Structure of the Mathematical Model, Limitations of Operations Research, Engineering Applications, Linear Programming: Introduction, Requirements, Mathematical Formulation, Case Studies, Graphical Methods, Applications, Advantages, Limitations. Simplex Algorithms and methods, Duality Theorem, Dual simplex method, Sensitivity and Post Optimality Analysis. Transportation and Assignment Problem, Trans-shipment models. Integer Programming, Dynamic Programming, Classical Optimization techniques, Queuing theory, Game theory and its applications, Network Planning using PERT, CPM, Project crashing, Shortest path problem, Maximum flow problem, Minimum spanning tree problem, minimum cost flow problem, Resource leveling

Suggested Books:

1. Operation Research by J. K. Sharma; Publisher: Macmillan
2. Operations Research by Hamdi A. Taha, Publisher: Pearson
3. Optimization Techniques by C. Mohan and Kusum Deep; Publishers: New Age Science

SPD6203 Multirate signal processing

Fundamentals of Multirate Theory, The sampling theorem - sampling at subnyquist rate - Basic Formulations and schemes, Basic Multirate operations- Decimation and Interpolation - Digital Filter Banks- DFT Filter Bank,Identities- Polyphase representation, Maximally decimated filter banks: Polyphase representation - Errors in the QMF bank- Perfect reconstruction (PR) QMF Bank - Design of an alias free QMF Bank; M-channel perfect reconstruction filter banks,Uniform band and non-uniform filter bank - tree structured filter bank- Errors created by filter bank system-Polyphase representation- perfect reconstruction systems; Perfect reconstruction (PR) filter banks, Paraunitary PR Filter Banks- Filter Bank Properties induced by paraunitarity- Two channel FIR paraunitary,QMF Bank- Linear phase PR Filter banks- Necessary conditions for Linear phase property- Quantization,Effects: -

Types of quantization effects in filter banks. - coefficient sensitivity effects, dynamic range and scaling; Cosine Modulated filter banks, Cosine Modulated pseudo QMF Bank- Alias cancellation- phase - Phase Distortion-Closed form expression-Polyphase structure- PR Systems; Optimising of design parameters, Balanced and Symmetrical Multirate Filters, Application and design case study. Two recent research papers on MultiRate Filter design.

Suggested Books:

1. B.W. Suter, "Multirate and Wavelet Signal Processing", Elsevier, 1997.
2. V.M. Gadre and A. Abhyankar, "Multiresolution & Multirate Signal Processing", McGraw-Hill Education, 2017.