UNIVERSITY OF MUMBAI

Revised Syllabus for the
Master of Engineering (M. E.)
Signal Processing

(As per Choice Based Credit and Grading System with effect from the academic year 2016–2017)

From Co-ordinator's Desk:-

To meet the challenge of ensuring excellence in engineering education, the issue of quality needs to be addressed, debated taken forward in a systematic manner. Accreditation is the principal means of quality assurance in higher education. The major emphasis of accreditation process is to measure the outcomes of the program that is being accredited. In line with this Faculty of Technology of University of Mumbai has taken a lead in incorporating philosophy of outcome based education in the process of curriculum development.

Faculty of Technology, University of Mumbai, in one of its meeting unanimously resolved that, each Board of Studies shall prepare some Program Educational Objectives (PEO's) give freedom to affiliated Institutes to add few (PEO's) course objectives course outcomes to be clearly defined for each course, so that all faculty members in affiliated institutes understand the depth approach of course to be taught, which will enhance learner's learning process. It was also resolved that, maximum senior faculty from colleges experts from industry to be involved while revising the curriculum. I am happy to state that, each Board of studies has adhered to the resolutions passed by Faculty of Technology, developed curriculum accordingly. In addition to outcome based education, **Choice Based Credit and Grading System** is also introduced to ensure quality of engineering education.

Choice Based Credit and Grading System enables a much-required shift in focus from teacher-centric to learner-centric education, since the workload estimated is based on the investment of time in learning and not in teaching. It also focuses on continuous evaluation which will enhance the quality of education. University of Mumbai has taken a lead in implementing the system through its affiliated Institutes. Faculty of Technology has devised a transparent credit assignment policy adopted ten point's scale to grade learner's performance. **Choice Based Credit and Grading System** will be implemented for First year Master of Engineering from the academic year 2016-2017. Subsequently this system will be carried forward for Second Year Master of Engineering in the academic year 2017-2018.

Dr. S. K. Ukarande
Co-ordinator,
Faculty of Technology,
Member - Academic Council
University of Mumbai, Mumbai

Preamble:

The curriculum in higher education is a living entity. It evolves with time; it reflects the ever changing needs of the society and keeps pace with the growing talent of the students and the faculty. The engineering education in India is expanding in manifolds and the main challenge is the quality of education. All stakeholders are very much concerned about it. The curriculum of Electronics & Telecommunication in Mumbai University is no exception. In keeping with the demands of the changing times, it contains innovative features. The exposure to the latest technology and tools used all over the world is given by properly selecting the subjects. It is designed in such a way to incorporate the requirements of various industries. The major emphasis of this process is to measure the outcomes of the program. Program outcomes are essentially a range of skills and knowledge that a student will have at the time of post-graduation. So the curriculum must be refined and updated to ensure that the defined objectives and outcomes are achieved.

I, as Chairman Ad-hoc Board of Studies in Electronics and Telecommunication Engineering, University of Mumbai, happy to state here that, the heads of the department and senior faculty from various institutes took timely and valuable initiative to frame the Program Educational objectives as listed below.

Objectives:

1. To produce Electronics & Telecommunication engineers, having strong theoretical foundation, good design experience and exposure to research and development.
2. To produce researcher who have clear thinking, articulation and interest to carry out theoretical and/or applied research resulting in significant advancement in the field of specialization.
3. To develop an ability to identify, formulate and solve electronics and telecommunication engineering problems in the latest technology.
4. To develop the ability among students to synthesize data and technical concepts from applications to product design.

These are the suggested and expected main objectives, individual affiliated institutes may add further in the list. I believe that the small step taken in the right direction will definitely help in providing quality education to the stake holders.

This book of curricula is the culmination of large number of faculty members and supporting staff. It also reflects the creative contribution of hundreds of teachers – both serving and retired. I sincerely hope that the faculty and students of Electronics and Telecommunication in Mumbai University will take full advantage of dynamic features of curriculum and make teaching-learning process a truly sublime experience for all.

At the end I must extend my gratitude to all experts and colleagues who contributed to make curriculum competent at par with latest technological development in the field of Electronics & Telecommunication Engineering.

Dr. Uttam D. Kolekar

Chairman, Ad-hoc Board of Studies in Electronics and Telecommunication Engineering

University of Mumbai
Program Structure for
ME Signal Processing
(w.e.f. A.Y. 2016-2017)
Semester I

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tut.	Theory	TW/ Practical	Tut.	Total
SPC101	Signal Detection and Estimation Theory	4	-	-	4	--	-	4
SPC102	Digital Signal Processing	4	-	-	4	--	-	4
SPC103	Image Processing	4	-	-	4	--	-	4
SPDLO1	Department Level Optional Course-I	4	-	-	4	--	-	4
ILO101	Institute Level Optional Course-I	3	-	-	3	--	-	3
SPL101	Laboratory-I: DSP Processors	--	2	-	-	1	-	1
SPL102	Laboratory-II: Image Processing	--	2	-	-	1	-	1
	Total	19	04	-	19	2	-	21

Subject Code	Subject Name	Examination Scheme							
		Theory							
		Internal Assessment			End Sem Exam	Exam Duration (hrs)	Term Work	Pract./ oral	Total
		Test 1	Test 2	Avg					
SPC101	Signal Detection and Estimation Theory	20	20	20	80	03	-	-	100
SPC102	Digital Signal Processing	20	20	20	80	03	-	-	100
SPC103	Image Processing	20	20	20	80	03	-	-	100
SPDLO1	Department Level Optional Course-I	20	20	20	80	03	-	-	100
ILO 101	Institute Level Optional Course-I	20	20	20	80	03	-	-	100
SPL101	Laboratory-I: DSP Processors	-	-	-	-	-	25	25	50
SPL102	Laboratory-II: Image Processing	-	-	-	-	-	25	25	50
	Total	100	100	100	400	-	50	50	600

Subject Code (SPDLO1)	Department Level Optional Course-I
SPDLO1011	Radar and Satellite Signal Processing and Applications
SPDLO1012	DSP Processors
SPDLO1013	Speech Processing
SPDLO1014	VSLI Signal Processing

Subject Code ILO1	Institute Level Optional Course-I
ILO1011	Product Life cycle Management
ILO1012	Reliability Engineering
ILO1013	Management Information System
ILO1014	Design of Experiments
ILO1015	Operation Research
ILO1016	Cyber Security and Laws
ILO1017	Disaster Management and Mitigation Measures
ILO1018	Energy Audit and Management

Semester II

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tut.	Theory	TW/ Practical	Tut.	Total
SPC201	Adaptive Signal Processing	4	-	-	4	--	-	4
SPC202	Signal processing Algorithms and Applications	4	-	-	4	--	-	4
SPC203	Video Processing	4	-	-	4	--	-	4
SPDLO2	Department Level Optional Course-II	4	-	-	4	--	-	4
ILO2	Institute Level Optional Course-II	3	-	-	3	--	-	3
SPL201	Laboratory III: Adaptive Signal Processing and Signal processing Algorithms and Applications	--	2	-	-	1	-	1
SPL202	Laboratory IV: Video Processing	--	2	-	-	1	-	1
	Total	19	04	-	19	2	-	21

Subject Code	Subject Name	Examination Scheme							
		Theory					Credits Assigned		
		Internal Assessment			End Sem Exam	Exam Duration (hrs)	Term Work	Pract./ oral	Total
		Test 1	Test 2	Avg					
SPC201	Adaptive Signal Processing	20	20	20	80	03	-	-	100
SPC202	Signal processing Algorithms and Applications	20	20	20	80	03	-	-	100
SPC203	Video Processing	20	20	20	80	03	-	-	100
SPDLO2	Department Level Optional Course-II	20	20	20	80	03	-	-	100
ILO202	Institute Level Optional Course-II	20	20	20	80	03	-	-	100
SPL201	Laboratory III: Adaptive Signal Processing and Signal processing Algorithms and Applications	-	-	-	-	-	25	25	50
SPL202	Laboratory IV: Video Processing	-	-	-	-	-	25	25	50
	Total	100	100	100	400	-	50	50	600

Subject Code SPDLO2	Department Level Optional Course-II
SPDLO2021	Wavelet Transform and Applications
SPDLO2022	Biomedical Signal Processing
SPDLO2023	DSP System Design
SPDLO2024	Wireless Network

Subject Code ILO2	Institute Level Optional Course-II
ILO2021	Project Management
ILO2022	Finance Management
ILO2023	Entrepreneurship Development and Management
ILO2024	Human Resource Management
ILO2025	Professional Ethics and CSR
ILO2026	Research Methodology
ILO2027	IPR and Patenting
ILO2028	Digital Business Management
ILO2029	Environmental Management

Semester-III

Subject Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract	Tut.	Theory	TW/ Pract	Tut.	Total
SPS301	Special topic seminar	--	6	--	--	3	--	3
SPD301	Dissertation -I	--	24	--	--	12	--	12
	Total	**--**	**30**	--	--	**15**	--	**15**

Subject Code	Subject Name	Examination Scheme						
		Theory				Credits Assigned		
		Internal Assessment			End Sem Exam	Term Work	Pract./ oral	Total
		Test 1	Test 2	Avg				
SPS301	Special topic seminar	-	-	-	-	50	50	100
SPD301	Dissertation -I	-	-	-	-	100	-	100
	Total	-	-	-	-	**150**	**50**	**200**

Semester-IV

Subject Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	**Pract**	**Theory**	**TW/Pract**	**Total**
SPD401	Dissertation -II	--	30	--	15	15
	Total	**--**	**30**	**--**	**15**	**15**

Subject Code	Subject Name	Examination Scheme						
		Theory				**Credits Assigned**		
		Internal Assessment			**End Sem Exam**	**Term Work**	**Pract./ oral**	**Total**
		Test 1	**Test 2**	**Avg**				
SPD401	Dissertation -II	-	-	-	-	100	100	200
	Total	**-**	**-**	**-**	-	**100**	**100**	**200**

Subject Code	Subject Name	Credits
SPC101	**Signal Detection and Estimation Theory**	**04**

Course Pre-requisite:
    Signals and Systems, Random Signal Process

Course Objective:
To enable the student to understand the basic principles of random signal processing, spectral detection and estimation methods used in communication system design and their applications.

Course Outcome: Learner will able to

- Design System for estimation,
- Spectral Estimation
- perform wave formation Analysis of the System

Module No. and Title	Detailed content	Hours
1.Review of Signals And Systems	Introduction, System Theory, Stochastic Processes, Gauss-Markov Models, Representation of Stochastic Process, Likelihood and Sufficiency.	05
2. Detection Theory	Introduction, one way , two way ANOVA table, Hypothesis Testing, Decision Criteria, Multiple Measurements, Multiple-Hypothesis Testing, Composite Hypothesis Testing, Chi-square testing, Asymptotic Error Rate of LRT for Simple Hypothesis Testing, CFAR Detection, Sequential Detection : Wald's Test.	08
3.Detection Of Signals In Noise	Introduction, Detection of Known Signals in White Noise: The Correlation Receiver, Detection of Known Signals in Colored Noise, Detection of Known Signals in Noise: Maximum SNR Criterion, Solution of Integral Equations, Detection of Signals with Unknown Parameters.	08
4. Estimation Theory	Introduction, Estimation of Parameters, Random Parameters: Bayes Estimates, Estimation of Nonrandom Parameters, Properties of Estimators, Linear Mean-Square Estimation, Reproducing Densities.	08
5. Spectrum Estimation	Non-Parametric methods - Correlation method - Co-variance estimator - Performance analysis of estimators – Unbiased consistent estimators - Periodogram estimator - Barlett spectrum estimation - Model based approach - AR, MA, AR MA Signal modeling – Parameter estimation using Yule-Walker method.	08

6. Estimation Of Waveforms	Introduction, Linear MMSE Estimation of Waveforms: Preliminaries, Estimation of Stationary Processes: The Wiener Filter, Estimation of Nonstationary Processes: The Kalman Filter, Relation between the Kalman and Wiener Filters,	08
Total		**45**

Recommended Books:

1. Introduction to Statistical Signal Processing with Application by M.D. Srinath, P.K. Rajasekaran, R. Viswanathan, Prentice-Hall, Inc. Upper Saddle River, NJ,USA.
2. An Introduction to Statistical Signal Processing by Robert M. Gray and Lee D. Davisson, by Cambridge University Press

Reference Books:

1. Fundamentals of Statistical Signal Processing Volume-I: Estimation Theory by Steven Kay, Prentice Hall
2. Fundamentals of Statistical Signal Processing Volume-II: Detection Theory by Steve Kay, Prentice Hall
3. Fundamentals of Statistical Signal Processing Volume-III: Practical Algorithm Development by Steven Kay, Prentice Hall

Assessment

Internal: Assessment consists of two tests out of which; one should be compulsory class test (covering two modules) and the other is either a class test (2 modules from remaining syllabus) or assignment on live problems or course project.

End Semester: Some guidelines for setting the question papers are as, six questions to be
Examination set each of 20 marks, out of these, question number 1 will be compulsory and it will carry questions covering each module. From remaining questions any three questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of end semester examination.

Subject Code	Subject Name	Credits
SPC102	**Digital Signal Processing**	**4**

Prerequisite:
Signals and Systems, Random Signal Process

Course Objective:
To enable the student to understand the discrete-time signal transforms, digital filter design, optimal filtering, multi-rate digital signal processing

Course Outcome: Students will be able to
Design adaptive filters for a given application and to design multirate DSP systems.

Module No. and Title	Detailed content	Hours
1. **Orthogonal Transforms**	DFT, DCT and Haar; Properties of DFT; Computation of DFT: FFT and structures, Decimation in time, Decimation in frequency; Linear convolution using DFT	05
2. **Sampling And Reconstruction of Signals**	Sampling band-pass signals, band pass signal representation. Analog-to-digital and digital-to analog conversions	08
3. **Linear Prediction And Optimum Linear Filters**	Representation of a random process, Forward and backward linear prediction, Solution of normal equations, Properties of the linear error-prediction filters, AR lattice and ARMA lattice-ladder filters, Wiener filters for filtering and prediction.	08
4. **Power Spectrum Estimation**	Estimation of spectra from finite-duration observations of signals, Nonparametric methods for power spectrum estimation, Parametric methods for Power Spectrum Estimation, Minimum variance spectral estimation, Eigen analysis algorithm for spectral estimation.	08
5. **Multirate Signal Processing**	Basic structures for sampling rate conversion, Decimators and Interpolators; Multistage design of interpolators and decimators; Polyphase decomposition and FIR structures; Computationally efficient sampling rate converters; Arbitrary sampling rate converters based on interpolation algorithms: Lagrange interpolation, Spline interpolation; Quadrature mirror filter banks; Conditions for perfect reconstruction; Applications in sub band coding;	08
6. Analysis Offinite Wordlength Effect In Fixed-Point DSP Systems	Introduction, DSP arithmetic, ADC quantization noise & signal quality, Finite wordlength effects in IIR & FIR digital filters, Hilbert transform, Hilbert transform relations for causal signals, Karhunen-Loève transform. Introduction to linear prediction	08
	Total	**45**

Recommended Books:

1**. Discrete Time signal Processing** by Alan V. Oppenheim, Ronald Schafer, Pearson Education

2. Digital Signal Processing, Principles, algorithms and applications - J. Proakis, D. G. Manolakis, D. Sharma, Pearson Education.

3. Multirate Systems and Filter Banks-P.P. Vaidyanathan, Pearson.

4. Li Tan, **"Digital Signal Processing – Fundamentals and applications"**, Elsevier, 2008.

5. Sanjit K. Mitra, **"Digital Signal Processing"**, A Computer Based Approach, Tata McGraw Hill, 2001.

Assessment:

Internal:	Assessment consists of two tests out of which; one should be compulsory class test (covering two modules) and the other is either a class test (two modules from remaining syllabus) or assignment on live problems or course project.
End Semester:	Some guidelines for setting the question papers are as, six questions to be
Examination	set each of 20 marks, out of these, question number 1 will be compulsory and it will carry questions covering each module. From remaining questions any three questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of end semester examination.

Subject Code	Subject Name	Credits
SPC103	**Image Processing**	**04**

Course Pre-requisite:

- Signals and Systems
- Digital Signal Processing

Course Objectives:

- To understand the image fundamentals and mathematical transforms necessary for image processing and also to study the image enhancement technique, image segmentation and representation techniques.

Course Outcomes:

- Upon Completion of the course, the students will be able to understand image formation and the role human visual system in perception of gray and color image data.
- Student will be able to apply image processing techniques in both the spatial and frequency domains.
- Students will be to design image analysis techniques in the form of image segmentation and to evaluate the methodologies for segmentation.

Module No. And Title	Detailed content	Hours
1. **Fundamentals of Digital Image Processing**	Elements of visual perception, brightness, contrast, hue, saturation, mach band effect, 2D image transforms-DFT, DCT, KLT, and SVD. Image enhancement in spatial and frequency domain, Review of morphological image processing. Introduction tocolour Imaging processing, colour model- RGB, HIS, HSV	08
2. **Segmentation**	Edge detection, Thresholding, Region growing, Fuzzy clustering, Watershed algorithm, Active contour methods, Texture feature based segmentation, Model based segmentation, Wavelet based Segmentation methods	08

3.	Feature Extraction	First and second order edge detection operators, Phase congruency, Localized feature extraction detecting image curvature, shape features Hough transform, shape skeletonization, Boundary descriptors, Moments, Texture descriptors- Autocorrelation, Co-occurrence features, Runlength features, Fractal model based features, Gabor filter, wavelet features.	08
4.	Image Restoration	Basic Framework, Interactive Restoration, Image deformation and geometric transformations, image morphing, Restoration techniques, Noise characterization, Noise restoration filters, Adaptive filters, Linear, Position invariant degradations, Estimation of Degradation functions, Restoration from projections.	08
5.	Morphological Image Processing	Basics, Structuring Element, Erosion, Dilation, Opening, Closing, Hit-or-Miss Transform, Boundary Detection, Hole filling, Connected components, convex hull, thinning, thickening, skeletons, pruning, Geodesic Dilation, Erosion, Reconstruction by dilation and erosion.	08
6.	Image Registration	Registration- Preprocessing, Feature selection-points, lines, regions and templates Feature correspondence-Point pattern matching, Line matching, region matching Template matching. Transformation functions-Similarity transformation and Affine Transformation. Resampling-Nearest Neighbour and Cubic Splines	08
		Total	48

Recommended Books:

1. John C.Russ, "**The Image Processing Handbook**", CRC Press, 2007.
2. Mark Nixon, Alberto Aguado, "Feature Extraction and Image Processing", Academic Press, 2008.
3. ArdeshirGoshtasby, "2D and 3D Image registration for Medical, Remote Sensing and Industrial Applications", John Wiley and Sons, 2005.

Reference Books:

1. Rafael C. Gonzalez, Richard E. Woods, Digital Image Processing', Pearson, Education, Inc., Second Edition, 2004.
2. Anil K. Jain, Fundamentals of Digital Image Processing', Pearson Education, Inc., 2002.
3. Rick S.Blum, Zheng Liu, "Multisensory image fusion and its Applications", Taylor & Francis, 2006.

Assessment
Internal:　　　　　Assessment consists of two tests out of which; one should be compulsory class

test (covering two modules) and the other is either a class test (2 modules from remaining syllabus) or assignment on live problems or course project.

End Semester: Examination Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these, question number 1 will be compulsory and it will carry questions covering each module. From remaining questions any three questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of end semester examination.

Subject Code	Subject Name	Credits
SPDLO1011	**Radar and Satellite Signal Processing and Applications**	**04**

Course Pre-requisite:

Radar Engineering, Wave Propagation, Satellite Communication

Course Objectives:

To understand the Radar Signal acquisition and sampling in multiple domains to provide clear instruction in radar DSP basics and to equip the skills needed in both design and analysis of common radar algorithms.

Course Outcomes:

Upon Completion of the course, the students will be able to understand application of signal processing in radar system, different types of signal models used in radar, types of differential GPS systems and applications of signal processing in remote sensing.

Module No. and Title	Detailed content	Hours
1. **Introduction To Radar Systems**	History and application of radar, basic radar function, elements of pulsed radar, review of signal processing concepts and operations. A preview of basic radar signal processing, radar system components, advanced radar signal processing.	06
2. **Signal Models**	Components Of Radar Signals, Amplitude models, types of clutters, noise model and signal to noise ratio, frequency models, the doppler shift, spatial models, spectral model	06
3. **Sampling And Quantization of Pulsed Radar Signals**	Domains and criteria for sampling radar signals, Sampling in the fast time dimension, Sampling in slow time: selecting the pulse repetition interval, sampling the doppler spectrum, Sampling in the spatial and angle dimension, Quantization, I/Q Imbalance and Digital I/Q.	08
4. **Navigation, Tracking And Safety Systems**	Global Navigation Satellite Systems - Basic concepts of GPS. Space segment, Control segment, user segment, GPS constellation, GPS measurement characteristics, selective availability (AS), Anti spoofing (AS). Applications of Satellite and GPS for 3D position, Velocity, determination as function of time, Interdisciplinary applications. Regional Navigation Systems- Distress and Safety-Cospas-Sarsat-Inmarsat Distress System- Location-Based service.	10

Module No. and Title	Detailed content	Hours
5. Inertial Navigation And DifferentialGPS Systems	Introduction to Inertial Navigation- Inertial Sensors - Navigation Coordinates-System Implementations- System-Level Error Models- Introduction to Differential GPS- LADGPSWADGPS- WAAS - GEO Uplink Subsystem (GUS) - GEO Uplink Subsystem (GUS) Clock Steering Algorithms - GEO Orbit Determination - Problems	09
6. Remote SensingSystems And Techniques	Introduction - Commercial Imaging – Digital Globe – Geo Eye - Meteorology – Meteosat – Land Observation – Landsat- Remote Sensing Data- Sensors- Overview - Optical Sensors: Cameras- Non-Optical Sensors- Image Processing - Image Interpretation- System Characteristics. .	09
	Total	48

Recommended Books:

1. Fundamentals ofRadar Signal Processing, Mark A. Richards McGraw-Hill, New York, 2005

2. Radar systems, Peak Detection and Tracking, Michael O Kolawole, 2010, Elseveir

3. Introduction to Radar Systems 3/E, Skolnik, McGraw Hill.

4. Satellite systems for personal Applications, MadhavendraRichharia, A John Wiley and Sons, Ltd., Publication.

5. Dennis Roddy, 'Satellite Communication', McGraw Hill International, 4th Edition, 2006.

6. Wilbur L. Pritchard, Hendri G. Suyderhoud, Robert A. Nelson, 'Satellite Communication Systems Engineering', Prentice Hall/Pearson, 2007 (Books to be added)

Reference Books:

1) Principles of Radar and Sonar Signal Processing, Francois Le Chevalier, Artech House

2) Radar Principles, Peyton Z. Peebles, 2009 Wiley India

3) Radar Design Principles-Signal Processing and the environment, Fred E. Nathanson, PHI

4) Global Positioning Systems, Inertial Navigation, and Integration. Mohinder S. Grewal California State University at Fullerton, A John Wiley & Sons, Inc. Publication.

Assessment:

Internal: Assessment consists of two tests out of which; one should be compulsory class test (covering two modules) and the other is either a class test (two modules from remaining syllabus) or assignment on live problems or course project.

End Semester: Some guidelines for setting the question papers are as, six questions to be
Examination set each of 20 marks, out of these, question number 1 will be compulsory and it will carry questions covering each module. From remaining questions any three questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of end semester examination.

Subject Code	Subject Name	Credits
SPDLO1012	**DSP Processors**	**04**

Course Pre-requisite:

- Basics of Microprocessors

Course Objectives:

- To enable the students to understand the basic principles of working of DSP Processors, their architectures and applications.

Course Outcomes: Learner will able to

- Students will be able to understand the development of digital processors and Advanced DSP processors.

Module No. and Title	Detailed content	Hours
1. **Fundamentals of Programmable DSPs**	Introduction to DSP Processors: Differences between DSP and other µp architectures, their comparison and need for special ASPs, RISC & CISC CPUs. Multiplier and Multiplier accumulator – Modified Bus Structures and Memory access in PDSPs – Multiple access memory – Multi-port memory – VLIW architecture- Pipelining – Special Addressing modes in P-DSPs – On chip Peripherals.	10
2. **Tms320c5x Processor**	Architecture – Assembly language syntax - Addressing modes – Assembly language Instructions - Pipeline structure, Operation – Block Diagram of DSP starter kit – Application Programs for processing real time signals.	10
3. **Tms320c6x Processor**	Architecture of the C6x Processor - Instruction Set - DSP Development System: Introduction – DSP Starter Kit Support Tools- Code Composer Studio - Support Files - Programming Examples to Test the DSK Tools – Application Programs for processing real time signals	10
4. **ADSP Processors**	Architecture of ADSP-21XX and ADSP-210XX series of DSP processors- Addressing modes and assembly language instructions – Application programs –Filter design, FFT calculation.	10

5.	**Advanced Processors**	Architecture of TMS320C54X: Pipe line operation, Code Composer studio – Architecture of TMS320C6X - Architecture of Motorola DSP563XX – Comparison of the features of DSP family processors.	08
		Total	48

Recommended Books and**Reference Books:**

1. B.Venkataramani and M.Bhaskar, "Digital Signal Processors – Architecture, Programming and Applications" – Tata McGraw – Hill Publishing Company Limited. New Delhi, 2003.
2. Avtar Singh and S. Srinivasan, Digital Signal Processing – Implementations using DSP
3. Microprocessors with Examples from TMS320C54xx, cengage Learning India Private Limited, Delhi 2012
4. User guides Texas Instrumentation, Analog Devices, Motorola
5. RulphChassaing, Digital Signal Processing and Applications with the C6713 and C6416 DSK, A JOHN WILEY & SONS, INC, PUBLICATION, 2005

Assessment

Internal: Assessment consists of two tests out of which; one should be compulsory class test (covering two modules) and the other is either a class test (two modules from remaining syllabus) or assignment on live problems or course project.

End Semester: Some guidelines for setting the question papers are as, six questions to be
Examination set each of 20 marks, out of these, question number 1 will be compulsory and it will carry questions covering each module. From remaining questions any three questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of end semester examination.

Subject Code	Subject Name	Credits
SPDLO1013	**Speech Processing**	**04**

Course Pre-requisite:
- Signals and Systems
- Digital Signal Processing

Course Objectives:
- To study the basic concepts of speech and audio and to the analysis of various M-band filter banks for audio coding.
- To learn various transform coders for audio coding, to study the speech processing methods in time and frequency domain.

Course Outcomes:
- At the end of this course students are able to understand the applications of different coders for compression of speech signal.

Module No. and Title	Detailed content	Hours
1. **Mechanics Of Speech And Audio**	Introduction - Review Of Signal Processing Theory-Speech production mechanism – Nature of Speech signal – Discrete time modelling of Speech production – Classification of Speech sounds Phones – Phonemes – Phonetic and Phonemic alphabets – Articulatory features. Absolute Threshold of Hearing - Critical Bands-Simultaneous Masking, Masking-Asymmetry, and the Spread of Masking- Non simultaneous Masking - Perceptual Entropy - Basic measuring philosophy - Subjective versus objective perceptual testing - The perceptual audio quality measure (PAQM) - Cognitive effects in judging audio quality.	08
2. **Time-Frequency Analysis: Filter Banks And Trans-forms**	Introduction -Analysis-Synthesis Framework for M-band Filter Banks- Filter Banks for Audio Coding: Design Considerations - Quadrature Mirror and Conjugate Quadrature Filters- Tree- Structured QMF and CQF M-band Banks - Cosine Modulated "Pseudo QMF" M-band Banks - Cosine Modulated Perfect Reconstruction (PR) M-band Banksand the Modified Discrete Cosine Transform (MDCT) - Discrete Fourier and Discrete Cosine Transform - Pre-echo Distortion- Preecho Control Strategies.	10

3.	**Audio Coding And Transform Coders**	Introduction, Detection of Known Signals in White Noise: The Correlation Receiver, Detection of Known Signals in Colored Noise, Detection of Known Signals in Noise: Maximum SNR Criterion, Solution of Integral Equations, Detection of Signals with Unknown Parameters.	10
4.	**Time And Frequency Domain Methods For Speech Processing**	Time domain parameters of Speech signal – Methods for extracting the parameters Energy Average Magnitude – Zero crossing Rate – Silence Discrimination using ZCRand energy Short Time Fourier analysis – Formant extraction – Pitch Extraction using time and frequency domain methods **Homomorphic Speech Analysis:** Cepstral analysis of Speech – Formant and Pitch Estimation – HomomorphicVocoders.	10
5.	**Linear Predictive Analysis Of Speech**	Formulation of Linear Prediction problem in Time Domain – Basic Principle – Auto correlation method – Covariance method – Solution of LPC equations – Cholesky method – Durbin's Recursive algorithm – lattice formation and solutions – Comparison of different methods – Application of LPC parameters – Pitch detection using LPC parameters – Formant analysis – VELP – CELP.	10
	Total		48

Recommended Books:

1. Digital Audio Signal Processing, Second Edition, UdoZolzer**,** A John Wiley& sons Ltd. Publications
2. Applications of Digital Signal Processing to Audio and Acoustics Mark Kahrs, Karlheinz Brandenburg, KLUWER ACADEMIC PUBLISHERS NEW YORK, BOSTON, DORDRECHT, LONDON, MOSCOW

Reference Books:

1. Digital Processing of Speech signals – L.R.Rabiner and R.W.Schaffer - Prentice Hall –1978

Assessment

Internal: Assessment consists of two tests out of which; one should be compulsory class test (covering two modules) and the other is either a class test (two modules from remaining syllabus) or assignment on live problems or course project.

End Semester: Some guidelines for setting the question papers are as, six questions to be
Examination set each of 20 marks, out of these, question number 1 will be compulsory and it will carry questions covering each module. From remaining questions any three questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of end semester examination.

Subject Code	Subject Name	Credits
SPDLO1014	**VLSI Signal Processing**	**04**

Course Pre-requisite:

- Basics of VLSI
- Signals and Systems
- Digital Signal Processing

Course Objectives:

- To introduce various techniques for the efficient mapping of DSP algorithms on hardware platform.

Course Outcomes: Learner will able to

- Understand the various techniques for the representation.
- Efficient hardware implementation of DSP algorithms.

Module No. and Title	Detailed content	Hours
1. Typical DSP Algorithms And Representation	1.1 **Review of typical DSP algorithms**: Convolution, Correlation, Discrete Cosine Transform (DCT), Vector Quantization, Decimator and Expander, Discrete Wavelet Transform (DWT), Digital Filter.	06
	1.2 **Representation of DSP Algorithm**: Block diagram, signal flow graph, data flow graph and dependence graph, DSP application demands and CMOS technologies.	
2. Iteration Bound	2.1 Loop Bound and Iteration Bound, Longest Path Algorithm, Minimum Cycle Algorithm, Iteration bound of MultirateData .	06
3. Pipelining And Parallel Processing	3.1 Pipelining of FIR Digital Filters, Data Broadcast Structures, Fine Grain pipelining.	10
	3.2 Parallel Processing, Designing of Parallel Processing system, pipelining and parallel processing for low power, combining pipelining and parallel processing	
4. Retiming	4.1Definition, Quantitative Description of Retiming, Prosperities of Retiming, Solving systems of inequalities, Cutset retiming and Pipelining, Retiming for clock period and register minimization	10
5. Unfolding And Folding	5.1 Algorithm for unfolding, Properties of Unfolding, Applications of unfolding: Sample period reduction, word-level and bit-level parallel processing.	10

	5.2 Folding Transformations, Register Minimization Techniques in Folded Architectures: Life time Analysis, Forward-Backward register allocation, register minimization of biquad and IIR filter, folding of multiratesystem .	
6. Fast Convolution	6.1 Cook-Toom Algorithm, Winograd Algorithm, Iterated Convolution, Cyclic Convolution.	06
Total		48

Textbooks:

1. "VLSI Digital Signal Processing Systems, Design and Implementation", by KeshabParhi, John-Wiley & sons.

2. "FPGA-based Implementation of Signal Processing Systems" by Roger Woods, John McAllister, Gaye Lightbody, Ying Yi, Wiley, John-Wiley and Sons .

References:

1. "Principles of CMOS VLSI Design", by Neil H.E.Weste, Kamran Eshraghian, Pearson Education.

2. "DSP Integrated Circuits", by Lars Wanhammar, Linkoping University, Academic Press Series in Engineering.

Assessment:

Internal: Assessment consists of two tests out of which; one should be compulsory class test (covering two modules) and the other is either a class test (two modules from remaining syllabus) or assignment on live problems or course project.

End Semester: Some guidelines for setting the question papers are as, six questions to be
Examination set each of 20 marks, out of these, question number 1 will be compulsory and it will carry questions covering each module. From remaining questions any three questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of end semester examination.

Course Code	Course Name	Credits
ILO1011	**Product Life Cycle Management**	**03**

Objectives:

1. To familiarize the students with the need, benefits and components of PLM
2. To acquaint students with Product Data Management & PLM strategies
3. To give insights into new product development program and guidelines for designing and developing a product
4. To familiarize the students with Virtual Product Development

Outcomes: Learner will be able to…

1. Gain knowledge about phases of PLM, PLM strategies and methodology for PLM feasibility study and PDM implementation.
2. Illustrate various approaches and techniques for designing and developing products.
3. Apply product engineering guidelines / thumb rules in designing products for moulding, machining, sheet metal working etc.
4. Acquire knowledge in applying virtual product development tools for components, machining and manufacturing plant

Module	Detailed Contents	Hrs
01	**Introduction to Product Lifecycle Management (PLM):**Product Lifecycle Management (PLM), Need for PLM, Product Lifecycle Phases, Opportunities of Globalization, Pre-PLM Environment, PLM Paradigm, Importance & Benefits of PLM, Widespread Impact of PLM, Focus and Application, A PLM Project, Starting the PLM Initiative, PLM Applications **PLM Strategies:**Industrial strategies, Strategy elements, its identification, selection and implementation, Developing PLM Vision and PLM Strategy , Change management for PLM	10
02	**ProductDesign:**Product Design and Development Process, Engineering Design, Organization and Decomposition in Product Design, Typologies of Design Process Models, Reference Model, Product Design in the Context of the Product Development Process, Relation with the Development Process Planning Phase, Relation with the Post design Planning Phase, Methodological Evolution in Product Design, Concurrent Engineering, Characteristic Features of Concurrent Engineering, Concurrent Engineering and Life Cycle Approach, New Product Development (NPD) and Strategies, Product Configuration and Variant Management, The Design for X System, Objective Properties and Design for X Tools, Choice of Design for X Tools and Their Use in the Design Process	09
03	**Product Data Management (PDM):**Product and Product Data, PDM systems and importance, Components of PDM, Reason for implementing a PDM system, financial justification of PDM, barriers to PDM implementation	05
04	**Virtual Product Development Tools:**For components, machines, and manufacturing plants, 3D CAD systems and realistic rendering techniques, Digital mock-up, Model building, Model analysis, Modeling and simulations in Product Design, Examples/Case studies	05

05	**Integration of Environmental Aspects in Product Design:**Sustainable Development, Design for Environment,Need for Life Cycle Environmental Strategies, Useful Life Extension Strategies, End-of-Life Strategies, Introduction of Environmental Strategies into the Design Process, Life Cycle Environmental Strategies and Considerations for Product Design		05
06	**Life Cycle Assessment and Life Cycle Cost Analysis:**Properties, and Framework of Life Cycle Assessment, Phases of LCA in ISO Standards, Fields of Application and Limitations of Life Cycle Assessment, Cost Analysis and the Life Cycle Approach, General Framework for LCCA, Evolution of Models for Product Life Cycle Cost Analysis		05

Assessment:

Internal:

Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:

Some guidelines for setting up the question paper.Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCES:

1. John Stark, "Product Lifecycle Management: Paradigm for 21st Century Product Realisation", Springer-Verlag, 2004. ISBN: 1852338105
2. Fabio Giudice, Guido La Rosa, AntoninoRisitano, "Product Design for the environment-A life cycle approach", Taylor & Francis 2006, ISBN: 0849327229
3. SaaksvuoriAntti, ImmonenAnselmie, "Product Life Cycle Management", Springer, Dreamtech, ISBN: 3540257314
4. Michael Grieve, "Product Lifecycle Management: Driving the next generation of lean thinking", Tata McGraw Hill, 2006, ISBN: 0070636265

Course Code	Course Name	Credits
ILO1012	**Reliability Engineering**	**03**

Objectives:
1. To familiarize the students with various aspects of probability theory
2. To acquaint the students with reliability and its concepts
3. To introduce the students to methods of estimating the system reliability of simple and complex systems
4. To understand the various aspects of Maintainability, Availability and FMEA procedure

Outcomes: Learner will be able to…
1. Understand and apply the concept of Probability to engineering problems
2. Apply various reliability concepts to calculate different reliability parameters
3. Estimate the system reliability of simple and complex systems
4. Carry out a Failure Mode Effect and Criticality Analysis

Module	Detailed Contents	Hrs
01	**Probability theory:** Probability: Standard definitions and concepts; Conditional Probability, Baye's Theorem. **Probability Distributions:** Central tendency and Dispersion; Binomial, Normal, Poisson, Weibull, Exponential, relations between them and their significance. **Measures of Dispersion:** Mean, Median, Mode, Range, Mean Deviation, Standard Deviation, Variance, Skewness and Kurtosis.	08
02	**Reliability Concepts:** Reliability definitions, Importance of Reliability, Quality Assurance and Reliability, Bath Tub Curve. **Failure Data Analysis:** Hazard rate, failure density, Failure Rate, Mean Time To Failure (MTTF), MTBF, Reliability Functions. **Reliability Hazard Models:** Constant Failure Rate, Linearly increasing, Time Dependent Failure Rate, Weibull Model. Distribution functions and reliability analysis.	08
03	**System Reliability:** System Configurations: Series, parallel, mixed configuration, k out of n structure, Complex systems.	05
04	**Reliability Improvement:** Redundancy Techniques: Element redundancy, Unit redundancy, Standby redundancies. Markov analysis. System Reliability Analysis – Enumeration method, Cut-set method, Success Path method, Decomposition method.	08
05	**Maintainability and Availability:** System downtime, Design for Maintainability: Maintenance requirements, Design methods: Fault Isolation and self-diagnostics, Parts standardization and Interchangeability, Modularization and Accessibility, Repair Vs Replacement. Availability – qualitative aspects.	05
06	**Failure Mode, Effects and Criticality Analysis:** Failure mode effects analysis, severity/criticality analysis, FMECA examples. Fault tree construction, basic symbols, development of functional reliability block diagram, Fau1t tree analysis and Event tree Analysis	05

Assessment:

Internal:
Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:
Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**
1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCES:
1. L.S. Srinath, "Reliability Engineering", Affiliated East-Wast Press (P) Ltd., 1985.
2. Charles E. Ebeling, "Reliability and Maintainability Engineering", Tata McGraw Hill.
3. B.S. Dhillion, C. Singh, "Engineering Reliability", John Wiley & Sons, 1980.
4. P.D.T. Conor, "Practical Reliability Engg.", John Wiley & Sons, 1985.
5. K.C. Kapur, L.R. Lamberson, "Reliability in Engineering Design", John Wiley & Sons.
6. Murray R. Spiegel, "Probability and Statistics", Tata McGraw-Hill Publishing Co. Ltd.

Course Code	Course Name	Credits
ILO1013	**Management Information System**	**03**

Objectives:
1. The course is blend of Management and Technical field.
2. Discuss the roles played by information technology in today's business and define various technology architectures on which information systems are built
3. Define and analyze typical functional information systems and identify how they meet the needs of the firm to deliver efficiency and competitive advantage
4. Identify the basic steps in systems development

Outcomes: Learner will be able to…
1. Explain how information systems Transform Business
2. Identify the impact information systems have on an organization
3. Describe IT infrastructure and its components and its current trends
4. Understand the principal tools and technologies for accessing information from databases to improve business performance and decision making
5. Identify the types of systems used for enterprise-wide knowledge management and how they provide value for businesses

Module	Detailed Contents	Hrs
01	Introduction To Information Systems (IS): Computer Based Information Systems, Impact of IT on organizations, Imporance of IS to Society. Organizational Strategy, Competitive Advantages and IS.	4
02	Data and Knowledge Management: Database Approach, Big Data, Data warehouse and Data Marts, Knowledge Management. Business intelligence (BI): Managers and Decision Making, BI for Data analysis and Presenting Results	7
03	Ethical issues and Privacy: Information Security. Threat to IS, and Security Controls	7
04	Social Computing (SC): Web 2.0 and 3.0, SC in business-shopping, Marketing, Operational and Analytic CRM, E-business and E-commerce – B2B B2C. Mobile commerce.	7
05	Computer Networks Wired and Wireless technology, Pervasive computing, Cloud computing model.	6
06	Information System within Organization: Transaction Processing Systems, Functional Area Information System, ERP and ERP support of Business Process. Acquiring Information Systems and Applications: Various System development life cycle models.	8

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4. Only Four question need to be solved.

REFERENCES:
1. Kelly Rainer, Brad Prince,Management Information Systems, Wiley
2. K.C. Laudon and J.P. Laudon, Management Information Systems: Managing the Digital Firm, 10th Ed., Prentice Hall, 2007.
3. D. Boddy, A. Boonstra, Managing Information Systems: Strategy and Organization, Prentice Hall, 2008

Course Code	Course Name	Credits
ILO1014	**Design of Experiments**	**03**

Objectives:

1. To understand the issues and principles of Design of Experiments (DOE)
2. To list the guidelines for designing experiments
3. To become familiar with methodologies that can be used in conjunction with experimental designs for robustness and optimization

Outcomes: Learner will be able to…

1. Plan data collection, to turn data into information and to make decisions that lead to appropriate action
2. Apply the methods taught to real life situations
3. Plan, analyze, and interpret the results of experiments

Module	Detailed Contents	Hrs
01	**Introduction** 1.1 Strategy of Experimentation 1.2 Typical Applications of Experimental Design 1.3 Guidelines for Designing Experiments 1.4 Response Surface Methodology	06
02	**Fitting Regression Models** 2.1 Linear Regression Models 2.2 Estimation of the Parameters in Linear Regression Models 2.3 Hypothesis Testing in Multiple Regression 2.4 Confidence Intervals in Multiple Regression 2.5 Prediction of new response observation 2.6 Regression model diagnostics 2.7 Testing for lack of fit	08
03	**Two-Level Factorial Designs and Analysis** 3.1 The 2^2 Design 3.2 The 2^3 Design 3.3 The General 2^k Design 3.4 A Single Replicate of the 2^k Design 3.5 The Addition of Center Points to the 2^k Design, 3.6 Blocking in the 2^k Factorial Design 3.7 Split-Plot Designs	07
04	**Two-Level Fractional Factorial Designs and Analysis** 4.1 The One-Half Fraction of the 2^k Design 4.2 The One-Quarter Fraction of the 2^k Design 4.3 The General 2^{k-p} Fractional Factorial Design 4.4 Resolution III Designs 4.5 Resolution IV and V Designs 4.6 Fractional Factorial Split-Plot Designs	07
05	**Conducting Tests** 5.1 Testing Logistics	07

		5.2 Statistical aspects of conducting tests	
		5.3 Characteristics of good and bad data sets	
		5.4 Example experiments	
		5.5 Attribute Vs Variable data sets	
06		**Taguchi Approach** 6.1 Crossed Array Designs and Signal-to-Noise Ratios 6.2 Analysis Methods 6.3 Robust design examples	04

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REFERENCES:
1. Raymond H. Mayers, Douglas C. Montgomery, Christine M. Anderson-Cook, Response Surface Methodology: Process and Product Optimization using Designed Experiment, 3rd edition,John Wiley & Sons, New York, 2001
2. D.C. Montgomery, Design and Analysis of Experiments, 5th edition, John Wiley & Sons, New York, 2001
3. George E P Box, J Stuart Hunter, William G Hunter, Statics for Experimenters: Design, Innovation and Discovery, 2nd Ed. Wiley
4. W J Dimond, Peactical Experiment Designs for Engineers and Scintists, John Wiley and Sons Inc. ISBN: 0-471-39054-2
5. Design and Analysis of Experiments (Springer text in Statistics), Springer by A.M. Dean, and D. T.Voss
6. Phillip J Ross, "Taguchi Technique for Quality Engineering," McGrawHill
7. Madhav S Phadke, " Quality Engineering using Robust Design," Prentice Hall

Course Code	Course Name	Credits
ILO1015	**Operations Research**	**03**

Objectives:

1. Formulate a real-world problem as a mathematical programming model.
2. Understand the mathematical tools that are needed to solve optimization problems.
3. Use mathematical software to solve the proposed models.

Outcomes: Learner will be able to…

1. Understand the theoretical workings of the simplex method, the relationship between a linear program and its dual, including strong duality and complementary slackness.
2. Perform sensitivity analysis to determine the direction and magnitude of change of a model's optimal solution as the data change.
3. Solve specialized linear programming problems like the transportation and assignment problems, solve network models like the shortest path, minimum spanning tree, and maximum flow problems.
4. Understand the applications of integer programming and a queuing model and compute important performance measures

Module	Detailed Contents	Hrs
01	**Introduction to Operations Research**: Introduction, , Structure of the Mathematical Model, Limitations of Operations Research **Linear Programming**: Introduction, Linear Programming Problem, Requirements of LPP, Mathematical Formulation of LPP, Graphical method, Simplex Method Penalty Cost Method or Big M-method, Two Phase Method, Revised simplex method, **Duality**, Primal – Dual construction, Symmetric and Asymmetric Dual, Weak Duality Theorem, Complimentary Slackness Theorem, Main Duality Theorem, Dual Simplex Method, Sensitivity Analysis **Transportation Problem**: Formulation, solution, unbalanced Transportation problem. Finding basic feasible solutions – Northwest corner rule, least cost method and Vogel's approximation method. Optimality test: the stepping stone method and MODI method. **Assignment Problem**: Introduction, Mathematical Formulation of the Problem, Hungarian Method Algorithm, Processing of n Jobs Through Two Machines and m Machines, Graphical Method of Two Jobs m Machines Problem Routing Problem, Travelling Salesman Problem **Integer Programming Problem**: Introduction, Types of Integer Programming Problems, Gomory's cutting plane Algorithm, Branch and Bound Technique. Introduction to Decomposition algorithms.	14
02	**Queuing models**: queuing systems and structures, single server and multi-server models, Poisson input, exponential service, constant rate service, finite and infinite population	05
03	**Simulation**: Introduction, Methodology of Simulation, Basic Concepts, Simulation Procedure, Application of Simulation Monte-Carlo Method: Introduction, Monte-Carlo Simulation, Applications of Simulation, Advantages of Simulation, Limitations of Simulation	05

04	**Dynamic programming**. Characteristics of dynamic programming. Dynamic programming approach for Priority Management employment smoothening, capital budgeting, Stage Coach/Shortest Path, cargo loading and Reliability problems.	05
05	**Game Theory**. Competitive games, rectangular game, saddle point, minimax (maximin) method of optimal strategies, value of the game. Solution of games with saddle points, dominance principle. Rectangular games without saddle point – mixed strategy for 2 X 2 games.	05
06	**Inventory Models**: Classical EOQ Models, EOQ Model with Price Breaks, EOQ with Shortage, Probabilistic EOQ Model,	05

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4. Only Four question need to be solved.

REFERENCES:
1. Taha, H.A. "Operations Research - An Introduction", Prentice Hall, (7th Edition), 2002.
2. Ravindran, A, Phillips, D. T and Solberg, J. J. "Operations Research: Principles and Practice", John Willey and Sons, 2nd Edition, 2009.
3. Hiller, F. S. and Liebermann, G. J. "Introduction to Operations Research", Tata McGraw Hill, 2002.
4. Operations Research, S. D. Sharma, KedarNath Ram Nath-Meerut.
5. Operations Research, KantiSwarup, P. K. Gupta and Man Mohan, Sultan Chand & Sons.

Course Code	Course Name	Credits
ILO1016	**Cyber Security and Laws**	**03**

Objectives:

1. To understand and identify different types cybercrime and cyber law
2. To recognized Indian IT Act 2008 and its latest amendments
3. To learn various types of security standards compliances

Outcomes: Learner will be able to…

1. Understand the concept of cybercrime and its effect on outside world
2. Interpret and apply IT law in various legal issues
3. Distinguish different aspects of cyber law
4. Apply Information Security Standards compliance during software design and development

Module	Detailed Contents	Hrs
01	**Introduction to Cybercrime:** Cybercrime definition and origins of the world, Cybercrime andinformation security, Classifications of cybercrime, Cybercrime and the Indian ITA 2000, A global Perspective on cybercrimes.	4
02	**Cyber offenses & Cybercrime:** How criminal plan the attacks, Social Engg, Cyber stalking, Cyber café and Cybercrimes, Botnets, Attack vector, Cloud computing, Proliferation ofMobile and Wireless Devices, Trends in Mobility, Credit Card Frauds in Mobile and Wireless Computing Era, Security Challenges Posed byMobile Devices, Registry Settings for Mobile Devices, AuthenticationService Security, Attacks on Mobile/Cell Phones, Mobile Devices:Security Implications for Organizations, Organizational Measures forHandling Mobile, Devices-Related Security Issues, OrganizationalSecurity Policies and Measures in Mobile Computing Era, Laptops	9
03	**Tools and Methods Used in Cyberline** Phishing, Password Cracking, Keyloggers and Spywares, Virus and Worms, Steganography, DoS and DDoS Attacks, SQL Injection, Buffer Over Flow, Attacks on Wireless Networks, Phishing, Identity Theft (ID Theft)	6
04	**The Concept of Cyberspace** E-Commerce , The Contract Aspects in Cyber Law ,The Security Aspect of Cyber Law ,The Intellectual Property Aspect in Cyber Law , The Evidence Aspect in Cyber Law , The Criminal Aspect in Cyber Law, Global Trends in Cyber Law , Legal Framework for Electronic Data Interchange Law Relating to Electronic Banking , The Need for an Indian Cyber Law	8
05	**Indian IT Act.** Cyber Crime and Criminal Justice : Penalties, Adjudication and Appeals Under the IT Act, 2000, IT Act. 2008 and its Amendments	6
06	**Information Security Standard compliances** SOX, GLBA, HIPAA, ISO, FISMA, NERC, PCI.	6

Assessment:

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4. Only Four question need to be solved.

REFERENCES:
1. Nina Godbole, Sunit Belapure, *Cyber Security*, Wiley India, New Delhi
2. The Indian Cyber Law by Suresh T. Vishwanathan; Bharat Law House New Delhi
3. The Information technology Act, 2000; Bare Act- Professional Book Publishers, New Delhi.
4. Cyber Law & Cyber Crimes By Advocate Prashant Mali; Snow White Publications, Mumbai
5. Nina Godbole, *Information Systems Security,* Wiley India, New Delhi
6. Kennetch J. Knapp, *Cyber Security &Global Information Assurance* Information Science Publishing.
7. William Stallings*, Cryptography and Network Security,* Pearson Publication
8. Websites for more information is available on : The Information Technology ACT, 2008- TIFR : https://www.tifrh.res.in
9. Website for more information , A Compliance Primer for IT professional : https://www.sans.org/reading-room/whitepapers/compliance/compliance-primer-professionals-33538

Course Code	Course Name	Credits
ILO1017	**Disaster Management and Mitigation Measures**	**03**

Objectives:

1. To understand physics and various types of disaster occurring around the world
2. To identify extent and damaging capacity of a disaster
3. To study and understand the means of losses and methods to overcome /minimize it.
4. To understand role of individual and various organization during and after disaster
5. To understand application of GIS in the field of disaster management
6. To understand the emergency government response structures before, during and after disaster

Outcomes: Learner will be able to…

1. Get to know natural as well as manmade disaster and their extent and possible effects on the economy.
2. Plan of national importance structures based upon the previous history.
3. Get acquainted with government policies, acts and various organizational structure associated with an emergency.
4. Get to know the simple do's and don'ts in such extreme events and act accordingly.

Module	Detailed Contents	Hrs
01	**Introduction** 1.1 Definition of Disaster, hazard, global and Indian scenario, general perspective, importance of study in human life, Direct and indirect effects of disasters, long term effects of disasters. Introduction to global warming and climate change.	03
02	**Natural Disaster and Manmade disasters:** 1.2 *2.*1 Natural Disaster: Meaning and nature of natural disaster, Flood, Flash flood, drought, cloud burst, Earthquake, Landslides, Avalanches, Volcanic eruptions, Mudflow, Cyclone, Storm, Storm Surge, climate change, global warming, sea level rise, ozone depletion 1.3 Manmade Disasters: Chemical, Industrial, Nuclear and Fire Hazards. Role of growing population and subsequent industrialization, urbanization and changing lifestyle of human beings in frequent occurrences of manmade disasters.	09
03	**Disaster Management, Policy and Administration** 1.4 3.1 Disaster management: meaning, concept, importance, objective of disaster management policy, disaster risks in India, Paradigm shift in disaster management. 1.5 3.2 Policy and administration: 1.6 Importance and principles of disaster management policies, command and co-ordination of in disaster management, rescue operations-how to start with and how to proceed in due course of time, study of flowchart showing the entire process.	06
04	**Institutional Framework for Disaster Management in India:** 1.7 4.1 Importance of public awareness, Preparation and execution of emergency management programme.Scope and responsibilities of National Institute of Disaster Management (NIDM) and National disaster management authority (NDMA) in India.Methods and measures to avoid disasters, Management of casualties, set up of emergency facilities, importance of effective communication amongst different agencies in such situations. 1.8 4.2 Use of Internet and softwares for effective disaster management. Applications of	06

	GIS, Remote sensing and GPS in this regard.	
05	**Financing Relief Measures:** 1.9 5.1 Ways to raise finance for relief expenditure, role of government agencies and NGO's in this process, Legal aspects related to finance raising as well as overall management of disasters. Various NGO's and the works they have carried out in the past on the occurrence of various disasters, Ways to approach these teams. 1.10 5.2 International relief aid agencies and their role in extreme events.	09
06	**Preventive and Mitigation Measures:** 6.1 Pre-disaster, during disaster and post-disaster measures in some events in general 6.2 Structural mapping: Risk mapping, assessment and analysis, sea walls and embankments, Bio shield, shelters, early warning and communication 6.3 Non Structural Mitigation: Community based disaster preparedness, risk transfer and risk financing, capacity development and training, awareness and education, contingency plans. 6.4 Do's and don'ts in case of disasters and effective implementation of relief aids.	06

Assessment:

Internal:
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End Semester Theory Examination:
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REFERENCES:
1. 'Disaster Management' by Harsh K.Gupta, Universities Press Publications.
2. 'Disaster Management: An Appraisal of Institutional Mechanisms in India' by O.S.Dagur, published by Centre for land warfare studies, New Delhi, 2011.
3. 'Introduction to International Disaster Management' by Damon Copolla, Butterworth Heinemann Elseveir Publications.
4. 'Disaster Management Handbook' by Jack Pinkowski, CRC Press Taylor and Francis group.
5. 'Disaster management & rehabilitation' by Rajdeep Dasgupta, Mittal Publications, New Delhi.
6. 'Natural Hazards and Disaster Management, Vulnerability and Mitigation – R B Singh, Rawat Publications
7. Concepts and Techniques of GIS –C.P.Lo Albert, K.W. Yonng – Prentice Hall (India) Publications.

(Learners are expected to refer reports published at national and International level and updated information available on authentic web sites)

Course Code	Course Name	Credits
ILO1018	**Energy Audit and Management**	03

Objectives:

1. To understand the importance energy security for sustainable development and the fundamentals of energy conservation.
2. To introduce performance evaluation criteria of various electrical and thermal installations to facilitate the energy management
3. To relate the data collected during performance evaluation of systems for identification of energy saving opportunities.

Outcomes: Learner will be able to…

1. To identify and describe present state of energy security and its importance.
2. To identify and describe the basic principles and methodologies adopted in energy audit of an utility.
3. To describe the energy performance evaluation of some common electrical installations and identify the energy saving opportunities.
4. To describe the energy performance evaluation of some common thermal installations and identify the energy saving opportunities
5. To analyze the data collected during performance evaluation and recommend energy saving measures

Module	Detailed Contents	Hrs
01	**Energy Scenario:** Present Energy Scenario, Energy Pricing, Energy Sector Reforms, Energy Security, Energy Conservation and its Importance, Energy Conservation Act-2001 and its Features. Basics of Energy and its various forms, Material and Energy balance	04
02	**Energy Audit Principles:** Definition, Energy audit- need, Types of energy audit, Energy management (audit) approach-understanding energy costs, Bench marking, Energy performance, Matching energy use to requirement, Maximizing system efficiencies, Optimizing the input energy requirements, Fuel and energy substitution. Elements of monitoring& targeting; Energy audit Instruments; Data and information-analysis. Financial analysis techniques: Simple payback period, NPV, Return on investment (ROI), Internal rate of return (IRR)	08
03	**Energy Management and Energy Conservation in Electrical System:** Electricity billing, Electrical load management and maximum demand Control; Power factor improvement, Energy efficient equipments and appliances, star ratings. **Energy efficiency measures in lighting system, Lighting control:** Occupancy sensors, daylight integration, and use of intelligent controllers. Energy conservation opportunities in: water pumps, industrial drives, induction motors, motor retrofitting, soft starters, variable speed drives.	10
04	**Energy Management and Energy Conservation in Thermal Systems:** Review of different thermal loads; Energy conservation opportunities in: Steam distribution system, Assessment of steam distribution losses, Steam leakages, Steam trapping, Condensate and flash steam recovery system. General fuel economy measures in Boilers and furnaces, Waste heat recovery, use of insulation- types and application. HVAC system: Coefficient of performance, Capacity, factors affecting Refrigeration and Air Conditioning system performance and savings opportunities.	10

05	**Energy Performance Assessment:** On site Performance evaluation techniques, Case studies based on: Motors and variable speed drive, pumps, HVAC system calculations; Lighting System: Installed Load Efficacy Ratio (ILER) method, Financial Analysis.	04
06	**Energy conservation in Buildings:** Energy Conservation Building Codes (ECBC): Green Building, LEED rating, Application of Non-Conventional and Renewable Energy Sources	03

<u>Assessment:</u>

Internal:
Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:
Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**
1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCES:
1. Handbook of Electrical Installation Practice, Geofry Stokes, Blackwell Science
2. Designing with light: Lighting Handbook, By Anil Valia, Lighting System
3. Energy Management Handbook, By W.C. Turner, John Wiley and Sons
4. Handbook on Energy Audits and Management, edited by A. K. Tyagi, Tata Energy Research Institute (TERI).
5. Energy Management Principles, C.B.Smith, Pergamon Press
6. Energy Conservation Guidebook, Dale R. Patrick, S. Fardo, Ray E. Richardson, Fairmont Press
7. Handbook of Energy Audits, Albert Thumann, W. J. Younger, T. Niehus, CRC Press
8. www.energymanagertraining.com
8. www.bee-india.nic.in

Subject Code	Subject Name	Teaching Scheme			Credits			
		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
SPL101	Laboratory 1	-	02	-	-	01	-	01

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term work	Practical	Oral	Total
		Internal Assessment			End Sem. Exam				
		Test1	Test2	Avg of Test1 and Test2					
SPL101	Laboratory I	-	-	-	-	25	25	-	50

Term Work:

At least minimum ten experiments covering entire syllabus of **DSP Processors** should be set to have well predefined inference and conclusion. The experiments should be student's centric and attempt should be made to make experiments more meaningful, interesting and innovative. Term work assessment must be based on oral performance of the student with every experiment. The grade must be converted to marks as per credit & grading system manual, and should be added and average. Base on above scheme grading & term work assessment should be done.
Practical & oral examination will be based on entire syllabus. The external examiner should be PG recognized teacher by University of Mumbai.

Subject Code	Subject Name	Teaching Scheme			Credits			
		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
SPL102	Laboratory II	-	02	-	-	01	-	01

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term work	Practical	Oral	Total
		Internal Assessment			End Sem. Exam				
		Test1	Test2	Avg of Test1 and Test2					
SPL102	Laboratory II	-	-	-	-	25	25	-	50

Term Work:

At least minimum ten experiments covering entire syllabus of **Image Processing** should be set to have well predefined inference and conclusion. The experiments should be student's centric and attempt should be made to make experiments more meaningful, interesting and innovative. Term work assessment must be based on oral performance of the student with every experiment. The grade must be converted to marks as per credit & grading system manual, and should be added and average. Base on above scheme grading & term work assessment should be done.
Practical & oral examination will be based on entire syllabus. The external examiner should be PG recognized teacher by University of Mumbai.

Subject Code	Subject Name	Credits
SPC201	**Adaptive Signal Processing**	**04**

Course Pre-requisite:
- Signals and Systems
- Digital Signal Processing

Course Objectives:
- To enable the student to understand the basic principles of adaptive signal processing, spectral detection and estimation methods used in communication and their applications.

Course Outcomes: Learner will able to
- Students will be able to understand the different types of adaptive filters used in signal processing applications.

Module No. and Title	Detailed content	Hours
1.Introduction	Introduction to Adaptive Processing General properties, filtering, prediction and smoothing, applications in Communications: Equalization, Echo cancellation, Noise cancellation.	07
2. Orthogonalized adaptive filters	Optimal Signal Processing Principles of orthogonality, minimum square error, Wiener Hopf equations, state space model, innovations process, Kalman filter equations. Linear Adaptive Equalization Gradient search and steepest descent adaptation algorithms, effect of Eigen value spread on stability and rate of convergence.	10
3. Least mean squares adaptive filter	Stochastic gradient descent using Least Mean Squares (LMS) algorithms, transient and steady state properties including convergence rate and mis-adjustment, least square estimation, normal equations, Recursive Least Squares (RLS) algorithms, relationship between RCS and Kalman filters.	11
4. Kalman filter theory	Kalman Filter theory; Introduction; recursive minimum mean square estimation for scalar random variables; statement of the kalman filtering problem: the innovations process, Estimation of state using the innovations process.	10

5. Fast recursive algorithms and applications	Introduction to Fast Recursive Algorithms for Equalization Adaptive linear prediction, lattice filtering for RLS. Other Applications Echo cancellation in wired systems, Noise cancellation	10
Total		48

Text Books:

1. Adaptive Signal Processing, B. Widrow, S. Stearns, Prentice-Hall, 1985.
2. Adaptive Signal Processing, L. Sibul, Ed., IEEE Press, 1987 .
3. Adaptive Filters: Structures, Algorithms and Applications, M. Honig, D. Messerschmitt, Kluwer, 1984.

ReferenceBooks:

1. Statistical and Adaptive Signal Processing: Spectral Estimation, Signal Modeling, Adaptive Filtering and Array Processing, D. Manolakis, V. Ingle, S. Kogan, McGraw Hill, 1999.
2. Fundamentals of Adaptive Filtering, Ali H. Sayed, John Wiley, 2003.
3. Mohinder S. Grewal, Angus P. Andrews, Kalman Filtering: Theory and Practice Using MATLAB, John Wiley & Sons. 2008.

Assessment:

Internal: Assessment consists of two tests out of which; one should be compulsory class test (covering two modules) and the other is either a class test (two modules from remaining syllabus) or assignment on live problems or course project.

End Semester: Some guidelines for setting the question papers are as, six questions to be
Examination set each of 20 marks, out of these, question number 1 will be compulsory and it will carry questions covering each module. From remaining questions any three questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of end semester examination.

Subject Code	Subject Name	Credits
SPC202	**Signal Processing Algorithms and Applications**	**04**

Course Pre-requisite:

Signals and Systems, Random Signal Processing

Course Objectives:

To enable the student to understand the basic principles of random signal processing, spectral detection and estimation methods used in communication system design and their applications..

Course Outcomes:
Students will be able to design adaptive filters for a given application and to design multirate DSP systems

Module No. and Title	Detailed content	Hours
1. **Orthogonal Transforms**	DFT, DCT and Haar; Properties of DFT; Computation of DFT: FFT and structures, Decimation in time, Decimation in frequency; Linear convolution using DFT	08
2. **Digital Filter Structures**	Basic FIR/IIR filter structures, FIR/IIR Cascaded lattice structures, Parallel allpass realization of IIR transfer functions, Sinecosine generator; Computational complexity of filter structures	07
3. **Data Compression**	An information theory primer: Histroic notes and information entropy, Source coding: Huffman algorithm, Delta Modulation, adaptive delta modulation and continuously variable slope delta modulation, differential Pulse code modulation and adaptive differential pulse code modulation	09
4. **Signal Processing In Communication Receiver**	Temporal Equalization, Space Time Equalization, Frequency Domain Equalization, Symbol Timing Recovery, Channel Quality Estimation, Automatic Frequency Control, Overall Receiver Block.	08
5. **Error Correcting Codes: Channel Coding: The Channel Model, The Channel Capacity**	Error Correcting codes: Hamming distance and error correction, liner blocks codes, cyclic codes, Bose, Chaudhari and Hocquenghem codes, convolution codes, Viterbi decoding, interleaving and concatenated codes and turbo codes.	08

6.	**Speech Coding**	Speech coding, adaptive predictive coding and sub-band coding, vocoders and liner predictive coding, Image coding, joint Photo graphic expert group(JPEG), moving pictures expert group(MPEG), the layer-3 of MPEG-1 algorithms(MP3), the Lempel-ZIV algorithms	08
		Total	**48**

Recommended Books:
1. R. Chassaing and D. Reay, Digital signal processing and applications with TMS320C6713 and TMS320C6416, Wiley, 2008.
2. S. K. Mitra, Digital Signal Processing: A Computer Based Approach, 3rd Edn., MH, 2008.
3. J. G. Proakis and D. G. Manolakis, Digital Signal Processing: Principles, Algorithms and Applications, Pearson Prentice Hall, 2007
4. Day Stranneby and William Walker, "Digital Signal processing and Applications", Elsevier Publications, second edition 2013.

Assessment:

Internal: Assessment consists of two tests out of which; one should be compulsory class test (covering two modules) and the other is either a class test (two modules from remaining syllabus) or assignment on live problems or course project.

End Semester: Some guidelines for setting the question papers are as, six questions to be
Examination set each of 20 marks, out of these, question number 1 will be compulsory and it will carry questions covering each module. From remaining questions any three questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of end semester examination.

Subject Code	Subject Name	Credits
SPC203	**Video Processing**	**04**

Course Pre-requisite:

Basic knowledge of error control and coding for communication and Image processing is expected.

Course Objectives:

To enable the student to understand basics of video, processing methods and different video coding techniques.

Course Outcomes:

The studentswill be able to do video coding with the help of different coding techniques.

Module No. and Title	Detailed content	Hours
1. Video Formation, Perception and Representation	**1.1Video Capture and Display:** Principles of Color Video, Video cameras, Video Cameras, Composite versus Component Models, Gamma Connection, Digital video.	
	1.2 Analog Video Raster: Progressive v/s Interlaced scans, Characterization of Video Raster, Spatial and Temporal resolution, Signal Bandwidth, Multiplexing of Luminance, Chrominance and Audio.	06
	1.3 Digital Video: Notation, ITU-R.BT.601 Digital Video Format, Other Digital Video Formats and Applications Digital Video Quality Measure.	
2. Fourier Analysis of Video Signals and Frequency Response of the Human Visual System.	**2.1**Multidimensional Continuous-Space Signals and Systems, Multidimensional discrete-Space Signals and systems	
	2.2 Frequency Domain Characterization of Video Signals: Spatial and Temporal Frequencies. Temporal Frequencies Caused by Linear Motion.	08
	2.3 Frequency Response of the Human Visual System: Temporal Frequency Response and Flicker Perception, Spatial Frequency Response, Spatiotemporal Frequency Response, Smooth Pursuit Eye Movement.	
3. Video Sampling	**3.1Basics of the Lattice Theory**	
	3.2Sampling of Video Signals Over Lattices : Required Sampling Rates, Sampling Video in Two Dimensions, Progressive versus Interlaced Scans, Sampling a Raster Scan: BT.601 Format Revisited, Sampling Video in Three Dimension, Spatial and Temporal Aliasing	08

Module No. and Title	Detailed content	Hours
	3.3 Filtering Operations in Cameras and Display: Devices, Camera Apertures. Display Apertures.	
4. **Video Sampling Rate Conversion**	**4.1 Conversion of Signals Sampled on Different Lattices:** Up-Conversion, Down-Conversion, Conversion between Arbitrary Lattices, Filter Implementation and Design, and other Interpolation Approaches.	08
	4.2 Sampling Rate Conversion of Video Signals: De-interlacing, Conversion between PAL and NTSC Signals, Motion-Adaptive Interpolation.	
5. **Two-Dimensional Motion Estimation**	**5.1. Optical Flow:** Two-Dimensional Motion versus Optical Flow, Optical Flow Equation **and** Ambiguity in Motion Estimation.	10
	5.2. **General Methodologies:** Motion Representation. Motion Estimation Criteria. Optimization Methods.	
	5.3. Pixel-Based Motion Estimation: Regularization Using the Motion Smoothness Constraints, Using a Multipoint Neighborhood, Pel-Recursive Methods.	
	5.4. Block-Matching Algorithm : The Exhaustive Block-Matching Algorithm, Fractional Accuracy Search, Fast Algorithm, Imposing Motion Smoothness Constraints, Phase Correlation Method, Binary Feature Matching	
	5.5. Multi-resolution Motion Estimation: General Formulation, Hierarchical Block Matching Algorithm.	
6. **Waveform-Based Video Coding**	**6.1. Block-Based Transform Coding.** : Overview, One-Dimensional Unitary Transform, Two-Dimensional Unitary Transform, The Discrete Cosine Transform, Bit Allocation and Transform Coding Gain, Optimal Transform Design and the KLT, DCT-Based Image Coders and the JPEG Standard, Vector Transform Coding.	08
	6.2 Predictive Coding: Overview, Optimal Predictor Design and Predictive Coding Gain, Spatial-Domain linear Prediction, Motion-Compensated Temporal Prediction.	
	6.3Video Coding Using Temporal Prediction and Transform Coding: Block-Based Hybrid Video Coding, Overlapped Block Motion Compensation, Coding Parameter Selection, Rate Control, and Loop Filtering.	
Total		**48**

Recommended Books:

1. "Multimedia Communication Technology", J.R.Ohm, Springer Publication.
2. "Video Coding for Mobile Communications" David Bull et al, Academic Press.
3. "Handbook on Image and Video Processing", A.I.Bovik, Academic Press.
4. "Digital Video", Tekalp, Prentice Hall.

Reference Books:

1. "Video Processing and Communications" Yao Wang, JornOstermann, Ya-Qin Zhang, Prentice Hall, 2002
2. "The Essential Guide to Video Processing" Alan C. Bovik, , Elsevier Science, edition 2, 2009
3. "Digital Video Processing" A. Murat Tekalp, Prentice Hall, edition 1, 1996

Assessment:

Internal:	Assessment consists of two tests out of which; one should be compulsory class test (covering two modules) and the other is either a class test (2 modules from remaining syllabus) or assignment on live problems or course project.
End Semester: Examination	Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these, question number 1 will be compulsory and it will carry questions covering each module. From remaining questions any three questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of end semester examination.

Subject Code	Subject Name	Credits
SPDLO2021	**Wavelet Transform and Applications**	**04**

Course Pre-requisite:

- Digital Signal Processing, Detection and Estimation Theory.

Course Objectives:

- To enable the student to understand the basics of wavelet transform, multi resolution analysis, continuous and discrete time wavelet transform.

Course Outcomes: Learner will able to

- At the end of this course the students are able to use the wavelet methods for compression of signals and image de-noising.

Module No. and Title	Detailed content	Hours
1. **Fundamentals**	Vector Spaces – Properties– Dot Product – Basis – Dimension, Orthogonality and Orthonormality – Relationship Between Vectors and Signals – Signal Spaces – Concept of Convergence – Hilbert Spaces for Energy Signals- Fourier Theory: Fourier series expansion, Fourier transform, Short time Fourier transform, Time-frequency analysis.	07
2. **Multi Resolution Analysis**	Definition of Multi Resolution Analysis (MRA) – Haar Basis – Construction of General Orthonormal MRA – Wavelet Basis for MRA – Continuous Time MRA Interpretation for the DTWT – Discrete Time MRA – Basis Functions for the DTWT – PRQMF Filter Banks.	11
3. **Continuous Wavelet Transforms**	Wavelet Transform – Definition and Properties – Concept of Scale and its Relation with Frequency – Continuous Wavelet Transform (CWT) – Scaling Function and Wavelet Functions (Daubechies Coiflet, Mexican Hat, Sinc, Gaussian, Bi Orthogonal) – Tiling of Time – Scale Plane for CWT.	10

4.	**Discrete Wavelet Transform**	Filter Bank and Sub Band Coding Principles – Wavelet Filters – Inverse DWT Computation by Filter Banks – Basic Properties of Filter Coefficients – Choice of Wavelet Function Coefficients – Derivations of Daubechies Wavelets – Mallat's Algorithm for DWT – MultiBand Wavelet Transforms Lifting Scheme- Wavelet Transform Using Polyphase Matrix Factorization – Geometrical Foundations of Lifting Scheme – Lifting Scheme in Z – Domain.	11
5.	**Applications**	Wavelet methods for signal processing- Image Compression Techniques: EZW–SPHIT Coding – Image Denoising Techniques: Noise Estimation – Shrinkage Rules – Shrinkage Functions – Edge Detection and Object Isolation, Image Fusion, and Object Detection.	09
	Total		**48**

Textbooks:

3. Rao R M and A S Bopardikar, ―Wavelet Transforms Introduction to theory and Applications, Pearson Education, Asia, 2000.
4. L.Prasad & S.S.Iyengar, Wavelet Analysis with Applications to Image Processing, CRC Press, 1997.

References:

1. J. C. Goswami and A. K. Chan, "Fundamentals of wavelets: Theory, Algorithms and Applications" Wiley Interscience Publication, John Wiley & Sons Inc., 1999.
2. M. Vetterli, J. Kovacevic, "Wavelets and subband coding" Prentice Hall Inc, 1995.
3. Stephen G. Mallat, "A wavelet tour of signal processing" 2 nd Edition Academic Press, 2000.
4. Soman K P and Ramachandran K I, ―Insight into Wavelets From Theory to practice, Prentice Hall, 2004.

Assessment:

Internal: Assessment consists of two tests out of which; one should be compulsory class test (covering two modules) and the other is either a class test (two modules from remaining syllabus) or assignment on live problems or course project.

End Semester: Some guidelines for setting the question papers are as, six questions to be
Examination set each of 20 marks, out of these, question number 1 will be compulsory and it will carry questions covering each module. From remaining questions any three questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of end semester examination.

Subject Code	Subject Name	Credits
SPDLO2022	**Biomedical Signal Processing**	**04**

Course Pre-requisite:

- Digital Signal Processing, Random Signal Processing, Basics of Biomedical Engineering

Course Objectives:

- To enable the student to understand the basic biomedical signals and its processing such as averaging, polishing.

Course Outcomes: Learner will able to

- At the end of this course the students are able to process the cardiological and neurological signal and to remove the noise from those signals.

Module No. and Title	Detailed content	Hours
1. Introduction	Cell structure, basic cell function, origin of bio-potentials, and electric activity of cells.	06
2. Biotransducers	Physiological parameters and suitable transducers for its measurements, operating principles and specifications for the transducers to measure parameters like blood flow, blood pressure, electrode sensor, temperature, displacement transducers. Cardiovascular system: Heart structure, cardiac cycle, ECG (electrocardiogram) theory (B.D.), PCG (phonocardiogram).EEG, X-Ray, Sonography, CT-Scan, The nature of biomedical signals.	09
3. Different sources of noise	Noise removal and signal compensation. Software based medical signal detection and pattern recognition.	07
4. Cardiological Signal Processing	Pre-processing. QRS Detection Methods. Rhythm analysis. Arrhythmia Detection Algorithms. Automated ECG Analysis.ECG Pattern Recognition. Heart rate variability analysis. Adaptive Noise Cancelling: Principles of Adaptive Noise Cancelling. Adaptive Noise Cancelling with the LMS Adaptation Algorithm. Noise Cancelling Method to Enhance ECG Monitoring. Fetal ECG Monitoring.	09
5. Signal averaging and polishing	Mean and trend removal, Prony's method, Prony's Method based on the Least Squares Estimate, Linear prediction.Yule – walker (Y –W) equations, Analysis of Evoked Potentials.	09
6. Neurological signal processing	Modeling of EEG Signals. Detection of spikes and spindles Detection of Alpha, Beta and Gamma Waves. Auto Regressive (A.R.) modeling of seizure EEG. Sleep	08

Stage analysis. Inverse Filtering. Least squares and polynomial modeling.	
Total	**48**

Textbooks:

1. "Simulation of Communication Systems, Modeling, Methodology and Techniques", M.C Jeruchim, P.Balaban, K.S. Shanmugan, Cluwer Academic Publishers, 2nd Edition 2002, ISBN0-306-46267-2.
2. Biomedical Signal Processing- Principles and Techniques - D.C.Reddy, 2005,TMH.

Reference books:

1. Digital Bio signal Processing - Weitkunat R, 1991, Elsevier.
2. Biomedical Signal Processing - Akay M, IEEE Press.
3. Biomedical Signal Processing -Vol. I Time & Frequency Analysis - Cohen.A, 1986, CRC Press.

Assessment:

Internal: Assessment consists of two tests out of which; one should be compulsory class test (covering two modules) and the other is either a class test (two modules from remaining syllabus) or assignment on live problems or course project.

End Semester: Some guidelines for setting the question papers are as, six questions to be
Examination set each of 20 marks, out of these, question number 1 will be compulsory and it will carry questions covering each module. From remaining questions any three questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of end semester examination.

Subject Code	Subject Name	Credits
SPDLO2023	**DSP System Design**	**04**

Course Pre-requisite:

- Digital signal Processing basics

Course Objectives:

- To enable the students to understand the basic working of Texas DSP Processors, their architectures and applications.
- To enable the students to understand the Digital signal processing Applications and current trends in DSP controller.

Course Outcomes: Learner will able to

- Understand the working of Texas DSP Processors
- Design FIR, IIR, FFT and DTMF digital Filter Design.
- Current trend in Digital Signal Processor

Module No. and Title	Detailed content	Hours
1. Introduction to a popular DSP from Texas Instruments	CPU Architecture - CPU Data Paths and Control - Timers - Internal Data/Program Memory - External Memory Interface - Programming - Instructions Set and Addressing Modes - Code Composer Studio - Code Generation Tools - Code Composer Studio Debug tools – Simulator	08
2. Analysis of finite word length effect in fixed-point DSP systems	Introduction, DSP arithmetic, ADC quantization noise & signal quality, Finite word length effects in IIR & FIR digital filters,Karhunen-Loève transform. Introduction to linear prediction, band pass sampling.	08
3. Sharc Digital Signal Processing	A popular DSP from Analog Devices - Sharc/ Tiger Sharc/ Blackfin (one of them) - Architecture – IOPRegisters - Peripherals - Synchronous Serial Port - Interrupts - Internal/External/Multiprocessor Memory Space - Multiprocessing –HostInterface - Link Ports.	10
4. Digital Signal Processing Applications	FIR and IIR Digital Filter Design, Filter Design Programs - Fourier Transform: DFT,FFT programs - Real Time Implementation : Implementation of Real Time Digital Filters using DSP - Implementation of FFTApplications using DSP – DTMF Tone Generation and Detection	10
5. Adaptive filters	MSE Approach and LMS Approach and its	06

		implementation	
6.	**Current Trends**	Current trend in Digital Signal Processor or DSP Controller- Architecture and their applications.	06
	Total		**48**

Reference Books:

5. NaimDahnoun, "*Digital Signal Processing Implementation using the TMS320C6000 DSP Platform*", 1st Edition.
6. T.J. Terrel and Lik-Kwan Shark, "*Digital Signal Processing - A Student Guide*",1st Edition; Macmillan Press Ltd.
7. David J Defatta J, Lucas Joseph G &Hodkiss William S, *"Digital Signal Processing: A System Design Approach"*, 1st Edition, JohnWiley
8. RulfChassaing, *"Digital Signal Processing and Application with C6713 and C6416 DSK"*, Wiley-Interscience Publication
9. Steven K Smith, Newnes, *"Digital Signal Processing-A Practical Guide for Engineers and Scientists"*, Elsevier Science
10. RulphChassaing, *"DSP Applications using 'C' and the TMS320C6X DSK"*, 1st EditionAndrew Bateman, Warren Yates, *"DigitalSignal Processing Design"*, 1st Edition
11. John G Proakis, Dimitris G Manolakis, *"Introduction to Digital Signal Processing"*, 2nd Ed.
12. KreigMarven& Gillian Ewers, *"A Simple approach to Digital Signal processing"*, 1st Edition, WielyInterscience
13. James H. McClellan, Ronald, Schaffer and Mark A. Yoder, *"DSP FIRST"* - A Multimedia App

Assessment:

Internal: Assessment consists of two tests out of which; one should be compulsory class test (covering two modules) and the other is either a class test (two modules from remaining syllabus) or assignment on live problems or course project.

End Semester: Some guidelines for setting the question papers are as, six questions to be
Examination set each of 20 marks, out of these, question number 1 will be compulsory and it will carry questions covering each module. From remaining questions any three questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of end semester examination.

Subject Code	Subject Name	Credits
SPDLO2024	**Wireless Network**	**04**

Course Pre-requisite:

- Random Signal Analysis, Wireless Communication

Course Objectives:

- To introduce the concepts of wireless communication and to make the students to know about the various propagation methods, Channel models, capacity calculations multiple antennas and multiple user techniques used in the mobile communication. To enhance the understanding of WiFi, 3G systems and 4G networks.

Course Outcomes: Learner will able to

- The students understand the state of art techniques in wireless communication. Students are enriched with the knowledge of present day technologies to enable them to face the world and contribute back as researchers.

Module No. and Title	Detailed content	Hours
6. **Wireless Channel Propagation And Model**	Propagation of EM signals in wireless channel – Reflection, diffraction and Scattering-Small scale fading-channel classification- channel models – COST -231 Hata model, Longley-Rice Model, NLOS Multipath Fading Models: Rayleigh, Rician, Nakagami, Composite Fading – shadowing Distributions, Link power budget Analysis.	**10**
7. **Diversity**	Capacity of flat and frequency selective fading channels-Realization of independent fading paths, Receiver Diversity: selection combining, Threshold Combining, Maximum-ratio Combining, Equal gain Combining. Transmitter Diversity: Channel known at transmitter, channel unknown at the transmitter.	**10**
8. **MIMO Communications**	Narrowband MIMO model, Parallel decomposition of the MIMO channel, MIMO channel capacity, MIMO Diversity Gain: Beamforming, Diversity-Multiplexing trade-offs, Space time Modulation and coding: STBC,STTC, Spacial Multiplexing and BLAST Architectures.	**09**

Module No. and Title	Detailed content	Hours
9. **Multi User Systems**	Multiple Access : FDMA,TDMA, CDMA,SDMA, Hybrid techniques, Random Access: ALOHA, SALOHA, CSMA, Scheduling, power control, uplink downlink channel capacity, multiuser diversity, MIMO-MU systems.	**10**
10. **Wireless Networks**	3G Overview, Migration path to UMTS, UMTS Basics, Air Interface, 3GPP Network Architecture, 4G features and challenges, Technology path, IMS Architecture - Introduction to wireless LANs - IEEE 802.11 WLANs - Physical Layer- MAC sublayer.	**09**
Total		**48**

Textbooks:

14. Andrea Goldsmith, Wireless Communications, Cambridge University Press, 2007.
15. HARRY R. ANDERSON, "Fixed Broadband Wireless System Design" John Wiley – India, 2003.
16. Andreas.F. Molisch, "Wireless Communications", John Wiley – India, 2006.
   Simon Haykin & Michael Moher, "Modern Wireless Communications", Pearson Education, 2007
17. Rappaport. T.S., "Wireless communications", Pearson Education, 2003.

References:

1. Clint Smith. P.E., and Daniel Collins, "3G Wireless Networks", 2nd Edition, Tata McGraw Hill, 2007.
2. Vijay. K. Garg, "Wireless Communication and Networking", Morgan Kaufmann Publishers, http://books.elsevier.com/9780123735805, 2007.
3. Kaveth Pahlavan, K. Prashanth Krishnamuorthy, "Principles of Wireless Networks", Prentice Hall of India, 2006.
4. William Stallings, "Wireless Communications and networks" Pearson / Prentice Hall of India, 2nd Ed., 2007.
5. Sumit Kasera and Nishit Narang, "3G Networks – Architecture, Protocols and Procedures", Tata McGraw Hill, 2007.

Assessment:

Internal: Assessment consists of two tests out of which; one should be compulsory class test (covering two modules) and the other is either a class test (two modules from remaining syllabus) or assignment on live problems or course project.

End Semester: Some guidelines for setting the question papers are as, six questions to be

Examination   set each of 20 marks, out of these, question number 1 will be compulsory and it will carry questions covering each module. From remaining questions any three questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of end semester examination.

Course Code	Course Name	Credits
ILO2021	**Project Management**	**03**

Objectives:
1. To familiarize the students with the use of a structured methodology/approach for each and every unique project undertaken, including utilizing project management concepts, tools and techniques.
2. To appraise the students with the project management life cycle and make them knowledgeable about the various phases from project initiation through closure.

Outcomes: Learner will be able to…
1. Apply selection criteria and select an appropriate project from different options.
2. Write work break down structure for a project and develop a schedule based on it.
3. Identify opportunities and threats to the project and decide an approach to deal with them strategically.
4. Use Earned value technique and determine & predict status of the project.
5. Capture lessons learned during project phases and document them for future reference

Module	Detailed Contents	Hrs
01	**Project Management Foundation:** Definition of a project, Project Vs Operations, Necessity of project management, Triple constraints, Project life cycles (typical & atypical) Project phases and stage gate process. Role of project manager. Negotiations and resolving conflicts. Project management in various organization structures. PM knowledge areas as per Project Management Institute (PMI).	5
02	**Initiating Projects:** How to get a project started, Selecting project strategically, Project selection models (Numeric /Scoring Models and Non-numeric models), Project portfolio process, Project sponsor and creating charter; Project proposal. Effective project team, Stages of team development & growth (forming, storming, norming & performing), team dynamics.	6
03	**Project Planning and Scheduling:** Work Breakdown structure (WBS) and linear responsibility chart, Interface Co-ordination and concurrent engineering, Project cost estimation and budgeting, Top down and bottoms up budgeting, Networking and Scheduling techniques. PERT, CPM, GANTT chart. Introduction to Project Management Information System (PMIS).	8
04	**Planning Projects:** Crashing project time, Resource loading and leveling, Goldratt's critical chain, Project Stakeholders and Communication plan. Risk Management in projects: Risk management planning, Risk identification and risk register. Qualitative and quantitative risk assessment, Probability and impact matrix. Risk response strategies for positive and negative risks	6

05	**5.1 Executing Projects:** Planning monitoring and controlling cycle. Information needs and reporting, engaging with all stakeholders of the projects. Team management, communication and project meetings. **5.2 Monitoring and Controlling Projects:** Earned Value Management techniques for measuring value of work completed; Using milestones for measurement; change requests and scope creep. Project audit. **5.3 Project Contracting** Project procurement management, contracting and outsourcing,	8
06	**6.1 Project Leadership and Ethics:** Introduction to project leadership, ethics in projects. Multicultural and virtual projects. **6.2 Closing the Project:** Customer acceptance; Reasons of project termination, Various types of project terminations (Extinction, Addition, Integration, Starvation), Process of project termination, completing a final report; doing a lessons learned analysis; acknowledging successes and failures; Project management templates and other resources; Managing without authority; Areas of further study.	6

Assessment:

Internal:
Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:
Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**
1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCES:
1. Jack Meredith & Samuel Mantel, Project Management: A managerial approach, Wiley India, 7thEd.
2. A Guide to the Project Management Body of Knowledge (PMBOK® Guide), 5th Ed, Project Management Institute PA, USA
3. Gido Clements, Project Management, Cengage Learning.
4. Gopalan, Project Management, , Wiley India
5. Dennis Lock, Project Management, Gower Publishing England, 9 th Ed.

Course Code	Course Name	Credits
ILO2022	**Finance Management**	**03**

Objectives:
1. Overview of Indian financial system, instruments and market
2. Basic concepts of value of money, returns and risks, corporate finance, working capital and its management
3. Knowledge about sources of finance, capital structure, dividend policy

Outcomes: Learner will be able to…
1. Understand Indian finance system and corporate finance
2. Take investment, finance as well as dividend decisions

Module	Detailed Contents	Hrs
01	**Overview of Indian Financial System:** Characteristics, Components and Functions of Financial System. **Financial Instruments:** Meaning, Characteristics and Classification of Basic Financial Instruments — Equity Shares, Preference Shares, Bonds-Debentures, Certificates of Deposit, and Treasury Bills. **Financial Markets:** Meaning, Characteristics and Classification of Financial Markets — Capital Market, Money Market and Foreign Currency Market **Financial Institutions:** Meaning, Characteristics and Classification of Financial Institutions — Commercial Banks, Investment-Merchant Banks and Stock Exchanges	06
02	**Concepts of Returns and Risks:** Measurement of Historical Returns and Expected Returns of a Single Security and a Two-security Portfolio; Measurement of Historical Risk and Expected Risk of a Single Security and a Two-security Portfolio. **Time Value of Money:** Future Value of a Lump Sum, Ordinary Annuity, and Annuity Due; Present Value of a Lump Sum, Ordinary Annuity, and Annuity Due; Continuous Compounding and Continuous Discounting.	06
03	**Overview of Corporate Finance:** Objectives of Corporate Finance; Functions of Corporate Finance—Investment Decision, Financing Decision, and Dividend Decision. **Financial Ratio Analysis:** Overview of Financial Statements—Balance Sheet, Profit and Loss Account, and Cash Flow Statement; Purpose of Financial Ratio Analysis; Liquidity Ratios; Efficiency or Activity Ratios; Profitability Ratios; Capital Structure Ratios; Stock Market Ratios; Limitations of Ratio Analysis.	09
04	**Capital Budgeting:** Meaning and Importance of Capital Budgeting; Inputs for Capital Budgeting Decisions; Investment Appraisal Criterion—Accounting Rate of Return, Payback Period, Discounted Payback Period, Net Present Value(NPV), Profitability Index, Internal Rate of Return (IRR), and Modified Internal Rate of Return (MIRR) **Working Capital Management:** Concepts of Meaning Working Capital; Importance of Working Capital Management; Factors Affecting an Entity's Working Capital Needs; Estimation of Working Capital Requirements;	10

	Management of Inventories; Management of Receivables; and Management of Cash and Marketable Securities.	
05	**Sources of Finance:** Long Term Sources—Equity, Debt, and Hybrids; Mezzanine Finance; Sources of Short Term Finance—Trade Credit, Bank Finance, Commercial Paper; Project Finance. **Capital Structure:** Factors Affecting an Entity's Capital Structure; Overview of Capital Structure Theories and Approaches— Net Income Approach, Net Operating Income Approach; Traditional Approach, and Modigliani-Miller Approach. Relation between Capital Structure and Corporate Value; Concept of Optimal Capital Structure	05
06	**Dividend Policy:** Meaning and Importance of Dividend Policy; Factors Affecting an Entity's Dividend Decision; Overview of Dividend Policy Theories and Approaches—Gordon's Approach, Walter's Approach, and Modigliani-Miller Approach	03

Assessment:

Internal:
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4. Only Four question need to be solved.

REFERENCES:
1. Fundamentals of Financial Management, 13th Edition (2015) by Eugene F. Brigham and Joel F. Houston; Publisher: Cengage Publications, New Delhi.
2. Analysis for Financial Management, 10th Edition (2013) by Robert C. Higgins; Publishers: McGraw Hill Education, New Delhi.
3. Indian Financial System, 9th Edition (2015) by M. Y. Khan; Publisher: McGraw Hill Education, New Delhi.
4. Financial Management, 11th Edition (2015) by I. M. Pandey; Publisher: S. Chand (G/L) & Company Limited, New Delhi.

Course Code	Course Name	Credits
ILO2023	**Enterpreneurship Development and Management**	**03**

Objectives:

1. To acquaint with entrepreneurship and management of business
2. Understand Indian environment for entrepreneurship
3. Idea of EDP, MSME

Outcomes: Learner will be able to…

1. Understand the concept of business plan and ownerships
2. Interpret key regulations and legal aspects of entrepreneurship in India
3. Understand government policies for entrepreneurs

Module	Detailed Contents	Hrs
01	**Overview Of Entrepreneurship:** Definitions, Roles and Functions/Values of Entrepreneurship, History of Entrepreneurship Development, Role of Entrepreneurship in the National Economy, Functions of an Entrepreneur, Entrepreneurship and Forms of Business Ownership Role of Money and Capital Markets in Entrepreneurial Development: Contribution of Government Agencies in Sourcing information for Entrepreneurship	04
02	**Business Plans And Importance Of Capital To Entrepreneurship:** Preliminary and Marketing Plans, Management and Personnel, Start-up Costs and Financing as well as Projected Financial Statements, Legal Section, Insurance, Suppliers and Risks, Assumptions and Conclusion, Capital and its Importance to the Entrepreneur **Entrepreneurship And Business Development:** Starting a New Business, Buying an Existing Business, New Product Development, Business Growth and the Entrepreneur Law and its Relevance to Business Operations	09
03	Women's Entrepreneurship Development, Social entrepreneurship-role and need, EDP cell, role of sustainability and sustainable development for SMEs, case studies, exercises	05
04	**Indian Environment for Entrepreneurship:** key regulations and legal aspects , MSMED Act 2006 and its implications, schemes and policies of the Ministry of MSME, role and responsibilities of various government organisations, departments, banks etc., Role of State governments in terms of infrastructure developments and support etc., Public private partnerships, National Skill development Mission, Credit Guarantee Fund, PMEGP, discussions, group exercises etc	08
05	**Effective Management of Business:** Issues and problems faced by micro and small enterprises and effective management of M and S enterprises (risk management, credit availability, technology innovation, supply chain management, linkage with large industries), exercises, e-Marketing	08

06	**Achieving Success In The Small Business:** Stages of the small business life cycle, four types of firm-level growth strategies, Options – harvesting or closing small business Critical Success factors of small business	05

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4. Only Four question need to be solved.

REFERENCES:
1. Poornima Charantimath, Entrepreneurship development- Small Business Enterprise, Pearson
2. Education Robert D Hisrich, Michael P Peters, Dean A Shapherd, Entrepreneurship, latest edition, The McGrawHill Company
3. Dr TN Chhabra, Entrepreneurship Development, Sun India Publications, New Delhi
4. Dr CN Prasad, Small and Medium Enterprises in Global Perspective, New century Publications, New Delhi
5. Vasant Desai, Entrepreneurial development and management, Himalaya Publishing House
6. Maddhurima Lall, Shikah Sahai, Entrepreneurship, Excel Books
7. Rashmi Bansal, STAY hungry STAY foolish, CIIE, IIM Ahmedabad
8. Law and Practice relating to Micro, Small and Medium enterprises, Taxmann Publication Ltd.
9. Kurakto, Entrepreneurship- Principles and Practices, Thomson Publication
10. Laghu Udyog Samachar
11. www.msme.gov.in
12. www.dcmesme.gov.in
13. www.msmetraining.gov.in

Course Code	Course Name	Credits
ILO2024	Human Resource Management	03

Objectives:

1. To introduce the students with basic concepts, techniques and practices of the human resource management.
2. To provide opportunity of learning Human resource management (HRM) processes, related with the functions, and challenges in the emerging perspective of today's organizations.
3. To familiarize the students about the latest developments, trends & different aspects of HRM.
4. To acquaint the student with the importance of inter-personal & inter-group behavioral skills in an organizational setting required for future stable engineers, leaders and managers.

Outcomes: Learner will be able to…

1. Understand the concepts, aspects, techniques and practices of the human resource management.
2. Understand the Human resource management (HRM) processes, functions, changes and challenges in today's emerging organizational perspective.
3. Gain knowledge about the latest developments and trends in HRM.
4. Apply the knowledge of behavioral skills learnt and integrate it with in inter personal and intergroup environment emerging as future stable engineers and managers.

Module	Detailed Contents	Hrs
01	**Introduction to HR** • Human Resource Management- Concept, Scope and Importance, Interdisciplinary Approach Relationship with other Sciences, Competencies of HR Manager, HRM functions. • Human resource development (HRD): changing role of HRM – Human resource Planning, Technological change, Restructuring and rightsizing, Empowerment, TQM, Managing ethical issues.	5
02	**Organizational Behavior (OB)** • Introduction to OB Origin, Nature and Scope of Organizational Behavior, Relevance to Organizational Effectiveness and Contemporary issues • Personality: Meaning and Determinants of Personality, Personality development, Personality Types, Assessment of Personality Traits for Increasing Self Awareness • Perception: Attitude and Value, Effect of perception on Individual Decision-making, Attitude and Behavior. • Motivation: Theories of Motivation and their Applications for Behavioral Change (Maslow, Herzberg, McGregor); • Group Behavior and Group Dynamics: Work groups formal and informal groups and stages of group development. Team Effectiveness: High performing teams, Team Roles, cross functional and self-directed team. • Case study	7

03	**Organizational Structure &Design** • Structure, size, technology, Environment of organization; Organizational Roles & conflicts: Concept of roles; role dynamics; role conflicts and stress. • Leadership: Concepts and skills of leadership, Leadership and managerial roles, Leadership styles and contemporary issues in leadership. • Power and Politics: Sources and uses of power; Politics at workplace, Tactics and strategies.	6
04	**Human resource Planning** • Recruitment and Selection process, Job-enrichment, Empowerment - Job-Satisfaction, employee morale. • Performance Appraisal Systems: Traditional & modern methods, Performance Counseling, Career Planning. • Training & Development: Identification of Training Needs, Training Methods	5
05	**Emerging Trends in HR** • Organizational development; Business Process Re-engineering (BPR), BPR as a tool for organizational development , managing processes & transformation in HR. Organizational Change, Culture, Environment • Cross Cultural Leadership and Decision Making**:** Cross Cultural Communication and diversity at work**,** Causes of diversity, managing diversity with special reference to handicapped, women and ageing people, intra company cultural difference in employee motivation.	6
06	**HR & MIS** Need, purpose, objective and role of information system in HR, Applications in HRD in various industries (e.g. manufacturing R&D, Public Transport, Hospitals, Hotels and service industries **Strategic HRM** Role of Strategic HRM in the modern business world, Concept of Strategy, Strategic Management Process, Approaches to Strategic Decision Making; Strategic Intent – Corporate Mission, Vision, Objectives and Goals **Labor Laws & Industrial Relations** Evolution of IR, IR issues in organizations, Overview of Labor Laws in India; Industrial Disputes Act, Trade Unions Act, Shops and Establishments Act	10

Assessment:

Internal:

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End Semester Theory Examination:

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4. Only Four question need to be solved.

REFERENCES:

1. Stephen Robbins, Organizational Behavior, 16th Ed, 2013
2. V S P Rao, Human Resource Management, 3rd Ed, 2010, Excel publishing
3. Aswathapa, Human resource management: Text & cases, 6th edition, 2011
4. C. B. Mamoria and S V Gankar, Dynamics of Industrial Relations in India, 15th Ed, 2015, Himalaya Publishing, 15thedition, 2015
5. P. Subba Rao, Essentials of Human Resource management and Industrial relations, 5th Ed, 2013, Himalaya Publishing
6. Laurie Mullins, Management & Organizational Behavior, Latest Ed, 2016, Pearson Publications

Course Code	Course Name	Credits
ILO2025	**Professional Ethics and Corporat Social Responsibility (CSR)**	**03**

Objectives:

1. To understand professional ethics in business
2. To recognized corporate social responsibility

Outcomes: Learner will be able to…

1. Understand rights and duties of business
2. Distinguish different aspects of corporate social responsibility
3. Demonstrate professional ethics
4. Understand legal aspects of corporate social responsibility

Module	Detailed Contents	Hrs
01	**Professional Ethics and Business:** The Nature of Business Ethics; Ethical Issues in Business; Moral Responsibility and Blame; Utilitarianism: Weighing Social Costs and Benefits; Rights and Duties of Business	04
02	**Professional Ethics in the Marketplace:** Perfect Competition; Monopoly Competition; Oligopolistic Competition; Oligopolies and Public Policy **Professional Ethics and the Environment:** Dimensions of Pollution and Resource Depletion; Ethics of Pollution Control; Ethics of Conserving Depletable Resources	08
03	**Professional Ethics of Consumer Protection:** Markets and Consumer Protection; Contract View of Business Firm's Duties to Consumers; Due Care Theory; Advertising Ethics; Consumer Privacy **Professional Ethics of Job Discrimination:** Nature of Job Discrimination; Extent of Discrimination; Reservation of Jobs.	06
04	**Introduction to Corporate Social Responsibility:** Potential Business Benefits—Triple bottom line, Human resources, Risk management, Supplier relations; Criticisms and concerns—Nature of business; Motives; Misdirection. Trajectory of Corporate Social Responsibility in India	05
05	**Corporate Social Responsibility:** Articulation of Gandhian Trusteeship Corporate Social Responsibility and Small and Medium Enterprises (SMEs) in India, Corporate Social Responsibility and Public-Private Partnership (PPP) in India	08
06	**Corporate Social Responsibility in Globalizing India:** Corporate Social Responsibility Voluntary Guidelines, 2009 issued by the Ministry of Corporate Affairs, Government of India, Legal Aspects of Corporate Social Responsibility—Companies Act, 2013.	08

Assessment:

Internal:

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End Semester Theory Examination:
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4. Only Four question need to be solved.

REFERENCES:

1. Business Ethics: Texts and Cases from the Indian Perspective (2013) by Ananda Das Gupta; Publisher: Springer.
2. Corporate Social Responsibility: Readings and Cases in a Global Context (2007) by Andrew Crane, Dirk Matten, Laura Spence; Publisher: Routledge.
3. Business Ethics: Concepts and Cases, 7th Edition (2011) by Manuel G. Velasquez; Publisher: Pearson, New Delhi.
4. Corporate Social Responsibility in India (2015) by BidyutChakrabarty, Routledge, New Delhi.

Course Code	Course Name	Credits
ILO2026	**Research Methodology**	**03**

Objectives:
1. To understand Research and Research Process
2. To acquaint students with identifying problems for research and develop research strategies
3. To familiarize students with the techniques of data collection, analysis of data and interpretation

Outcomes: Learner will be able to…
1. Prepare a preliminary research design for projects in their subject matter   areas
2. Accurately collect, analyze and report data
3. Present complex data or situations clearly
4. Review and analyze research findings

Module	Detailed Contents	Hrs
01	**Introduction and Basic Research Concepts** **1.1** Research – Definition; Concept of Construct, Postulate, Proposition, Thesis, Hypothesis, Law, Principle.Research methods vs Methodology **1.2** Need of Research in Business and Social Sciences **1.3** Objectives of Research **1.4 Issues** and Problems in Research **1.5** Characteristics of Research:Systematic, Valid, Verifiable, Empirical and Critical	**09**
02	**Types of Research** **2.1**. Basic Research **2.2**. Applied Research **2.3.** Descriptive Research **2.4.** Analytical Research **2.5**. Empirical Research **2.6** Qualitative and Quantitative Approaches	**07**
03	**Research Design and Sample Design** **3.1** Research Design – Meaning, Types and Significance **3.2** Sample Design – Meaning and Significance Essentials of a good sampling Stages in Sample Design Sampling methods/techniques Sampling Errors	**07**
04	**Research Methodology** **4.1** Meaning of Research Methodology **4.2**. Stages in Scientific Research Process: **a.** Identification and Selection of Research Problem **b.** Formulation of Research Problem **c.** Review of Literature **d.** Formulation of Hypothesis **e.** Formulation of research Design **f**. Sample Design **g.** Data Collection **h.** Data Analysis	**08**

	i. Hypothesis testing and Interpretation of Data **j.** Preparation of Research Report	
05	**Formulating Research Problem** **5.1** Considerations: Relevance, Interest, Data Availability, Choice of data, Analysis of data, Generalization and Interpretation of analysis	**04**
06	**Outcome of Research** **6.1** Preparation of the report on conclusion reached **6.2** Validity Testing & Ethical Issues **6.3** Suggestions and Recommendation	**04**

Assessment:

Internal:

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End Semester Theory Examination:

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4. Only Four question need to be solved.

REFERENCES:

1. Dawson, Catherine, 2002, Practical Research Methods, New Delhi, UBS Publishers Distributors.
2. Kothari, C.R.,1985, Research Methodology-Methods and Techniques, New Delhi, Wiley Eastern Limited.
3. Kumar, Ranjit, 2005, Research Methodology-A Step-by-Step Guide for Beginners, (2nded), Singapore, Pearson Education

Course Code	Course Name	Credits
ILO2027	**IPR and Patenting**	**03**

Objectives:

1. To understand intellectual property rights protection system
2. To promote the knowledge of Intellectual Property Laws of India as well as International treaty procedures
3. To get acquaintance with Patent search and patent filing procedure and applications

Outcomes: Learner will be able to…

1. understand Intellectual Property assets
2. assist individuals and organizations in capacity building
3. work for development, promotion, protection, compliance, and enforcement of Intellectual Property and Patenting

Module	Detailed Contents	Hr
01	**Introduction to Intellectual Property Rights (IPR)**: Meaning of IPR, Different category of IPR instruments - Patents, Trademarks,Copyrights, Industrial Designs, Plant variety protection, Geographical indications,Transfer of technology etc. **Importance of IPR in Modern Global Economic Environment:** Theories of IPR, Philosophical aspects of IPR laws, Need for IPR, IPR as an instrument of development	05
02	**Enforcement of Intellectual Property Rights:** Introduction, Magnitude of problem, Factors that create and sustain counterfeiting/piracy, International agreements, International organizations (e.g. WIPO, WTO) activein IPR enforcement **Indian Scenario of IPR:**Introduction, History of IPR in India, Overview of IP laws in India, Indian IPR, Administrative Machinery, Major international treaties signed by India, Procedure for submitting patent and Enforcement of IPR at national level etc.	07
03	**Emerging Issues in IPR:**Challenges for IP in digital economy, e-commerce, human genome,biodiversity and traditional knowledge etc.	05
04	**Basics of Patents:**Definition of Patents, Conditions of patentability, Patentable and non-patentable inventions, Types of patent applications (e.g. Patent of addition etc), Process Patent and Product Patent, Precautions while patenting, Patent specification Patent claims, Disclosures and non-disclosures, Patent rights and infringement, Method of getting a patent	07
05	**Patent Rules:** Indian patent act, European scenario, US scenario, Australia scenario, Japan scenario, Chinese scenario, Multilateral treaties where India is a member (TRIPS agreement, Paris convention etc.)	08

06	**Procedure for Filing a Patent (National and International):** Legislation and Salient Features, Patent Search, Drafting and Filing Patent Applications, Processing of patent, Patent Litigation, Patent Publicationetc, Time frame and cost, Patent Licensing, Patent Infringement **Patent databases:** Important websites, Searching international databases	07

Assessment:

Internal:
Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or at least 6 assignment on complete syllabus or course project.

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4. Only Four question need to be solved.

REFERENCE BOOKS:
1. Rajkumar S. Adukia, 2007, A Handbook on Laws Relating to Intellectual Property Rights in India, The Institute of Chartered Accountants of India
2. Keayla B K, Patent system and related issues at a glance, Published by National Working Group on Patent Laws
3. T Sengupta, 2011, Intellectual Property Law in India, Kluwer Law International
4. Tzen Wong and Graham Dutfield, 2010, Intellectual Property and Human Development: Current Trends and Future Scenario, Cambridge University Press
5. Cornish, William Rodolph & Llewelyn, David. 2010, Intellectual Property: Patents, Copyrights, Trade Marks and Allied Right, 7th Edition, Sweet & Maxwell
6. Lous Harns, 2012, The enforcement of Intellactual Property Rights: A Case Book, 3rd Edition, WIPO
7. Prabhuddha Ganguli, 2012, Intellectual Property Rights, 1st Edition, TMH
8. R Radha Krishnan & S Balasubramanian, 2012, Intellectual Property Rights, 1st Edition, Excel Books
9. M Ashok Kumar and mohd Iqbal Ali, 2-11, Intellectual Property Rights, 2nd Edition, Serial Publications
10. Kompal Bansal and Praishit Bansal, 2012, Fundamentals of IPR for Engineers, 1st Edition, BS Publications
11. Entrepreneurship Development and IPR Unit, BITS Pilani, 2007, A Manual on Intellectual Property Rights,
12. Mathew Y Maa, 2009, Fundamentals of Patenting and Licensing for Scientists and Engineers, World Scientific Publishing Company
13. N S Rathore, S M Mathur, Priti Mathur, Anshul Rathi, IPR: Drafting,Interpretation of Patent Specifications and Claims, New India Publishing Agency
14. Vivien Irish, 2005, Intellectual Property Rights for Engineers,IET
15. Howard B Rockman, 2004, Intellectual Property Law for Engineers and scientists, Wiley-IEEE Press

Course Code	Course Name	Credits
ILO2028	**Digital Business Management**	**03**

Objectives:
1. To familiarize with digital business concept
2. To acquaint with E-commerce
3. To give insights into E-business and its strategies

Outcomes: The learner will be able to …..
1. Identify drivers of digital business
2. Illustrate various approaches and techniques for E-business and management
3. Prepare E-business plan

Module	Detailed content	Hours
1	**Introduction to Digital Business-** Introduction, Background and current status, E-market places, structures, mechanisms, economics and impacts Difference between physical economy and digital economy, **Drivers of digital business**- Big Data & Analytics, Mobile, Cloud Computing, Social media, BYOD, and Internet of Things(digitally intelligent machines/services) Opportunities and Challenges in Digital Business,	09
2	**Overview of E-Commerce** **E-Commerce-** Meaning, Retailing in e-commerce-products and services, consumer behavior, market research and advertisement B2B-E-commerce-selling and buying in private e-markets, public B2B exchanges and support services, e-supply chains, Collaborative Commerce, Intra business EC and Corporate portals Other E-C models and applications, innovative EC System-From E-government and learning to C2C, mobile commerce and pervasive computing EC Strategy and Implementation-EC strategy and global EC, Economics and Justification of EC, Using Affiliate marketing to promote your e-commerce business, Launching a successful online business and EC project, Legal, Ethics and Societal impacts of EC	06
3	**Digital Business Support services**: ERP as e –business backbone, knowledge Tope Apps, Information and referral system **Application Development:** Building Digital business Applications and Infrastructure	06
4	**Managing E-Business**-Managing Knowledge, Management skills for e-business, Managing Risks in e –business Security Threats to e-business -Security Overview, Electronic Commerce Threats, Encryption, Cryptography, Public Key and Private Key Cryptography, Digital Signatures, Digital Certificates, Security Protocols over Public Networks: HTTP, SSL, Firewall as Security Control, Public Key Infrastructure (PKI) for Security, Prominent Cryptographic Applications	06

5	**E-Business Strategy**-E-business Strategic formulation- Analysis of Company's Internal and external environment, Selection of strategy, E-business strategy into Action, challenges and E-Transition (Process of Digital Transformation)	04
6	**Materializing e-business: From Idea to Realization**-Business plan preparation **Case Studies and presentations**	08

Assessment:

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References:

1. A textbook on E-commerce**,** Er Arunrajan Mishra, Dr W K Sarwade,Neha Publishers & Distributors, 2011
2. E-commerce from vision to fulfilment, Elias M. Awad, PHI-Restricted, 2002
3. Digital Business and E-Commerce Management, 6th Ed, Dave Chaffey, Pearson, August 2014
4. Introduction to E-business-Management and Strategy, Colin Combe, ELSVIER, 2006
5. Digital Business Concepts and Strategy, Eloise Coupey, 2nd Edition, Pearson
6. Trend and Challenges in Digital Business Innovation, VinocenzoMorabito, Springer
7. Digital Business Discourse Erika Darics, April 2015, Palgrave Macmillan
8. E-Governance-Challenges and Opportunities in : Proceedings in 2nd International Conference theory and practice of Electronic Governance
9. Perspectives the Digital Enterprise –A framework for Transformation, TCS consulting journal Vol.5
10. Measuring Digital Economy-A new perspective -DOI:10.1787/9789264221796-enOECD Publishing

Assessment:

Internal:

Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:

Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCES:

1. Environmental Management: Principles and Practice, C J Barrow, Routledge Publishers London, 1999
2. A Handbook of Environmental Management Edited by Jon C. Lovett and David G. Ockwell, Edward Elgar Publishing
3. Environmental Management,**T V Ramachandra and Vijay Kulkarni, TERI Press**
4. Indian Standard Environmental Management Systems — Requirements With Guidance For Use, Bureau Of Indian Standards, February 2005
5. Environmental Management: An Indian Perspective, S N Chary and Vinod Vyasulu, Maclillan India, 2000
6. Introduction to Environmental Management, Mary K Theodore and Louise Theodore, CRC Press
7. Environment and Ecology, Majid Hussain, 3rd Ed. Access Publishing.2015

Subject Code	Subject Name	Teaching Scheme			Credits			
		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
SPL201	**Laboratory III**	-	**02**	-	-	**01**	-	**01**

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				**Term work**	**Practical**	**Oral**	**Total**
		Internal Assessment			**End Sem. Exam**				
		Test1	Test2	Avg. of Test1 and Test2					
SPL201	**Laboratory III**	-	-	-	-	**25**	**25**	-	**50**

Term Work:

At least minimum ten experiments covering entire syllabus of **Adaptive Signal Processing and Signal processingAlgorithms and Application** should be set to have well predefined inference and conclusion. The experiments should be student's centric and attempt should be made to make experiments more meaningful, interesting and innovative. Term work assessment must be based on oral performance of the student with every experiment. The grade must be converted to marks as per credit & grading system manual, and should be added and average. Base on above scheme grading & term work assessment should be done.

Practical & oral examination will be based on entire syllabus.The external examiner should be PG recognized teacher by University of Mumbai.

Subject Code	Subject Name	Teaching Scheme			Credits			
		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
SPL202	**Laboratory IV**	-	**02**	-	-	**01**	-	**01**

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term work	Practical	Oral	Total
		Internal Assessment			End Sem. Exam				
		Test1	Test2	Avg. of Test1 and Test2					
SPL202	**Laboratory IV**	-	-	-	-	25	25	-	50

Term Work:
At least minimum ten experiments covering entire syllabus of **Video processing** should be set to have well predefined inference and conclusion. The experiments should be student's centric and attempt should be made to make experiments more meaningful, interesting and innovative. Term work assessment must be based on oral performance of the student with every experiment. The grade must be converted to marks as per credit & grading system manual, and should be added and average. Base on above scheme grading & term work assessment should be done.

Practical & oral examination will be based on entire syllabus.The external examiner should be PG recognized teacher by University of Mumbai.

Subject Code	Subject Name	Credits
SPS301	Seminar	03

Guidelines for Seminar

- Seminar should be based on thrust areas in Electronics and Telecommunication Engineering.

- Students should do literature survey and identify the topic of seminar and finalize in consultation with Guide/Supervisor. Students should use multiple literature and understand the topic and compile the report in standard format and present infront of Panel of Examiners appointed by the Head of the Department/Institute of respective Programme.

- Seminar should be assessed based on following points
  - Quality of Literature survey and Novelty in the topic
  - Relevance to the specialization
  - Understanding of the topic
  - Quality of Written and Oral Presentation

IMPORTANT NOTE:

1. Assessment of Seminar will be carried out by a pair of Internal and External examiner. The external examiner should be PG recognized teacher by University of Mumbai, OR faculty from Premier Educational Institutions /Research Organizations such as IIT, NIT, BARC, TIFR, DRDO, etc. OR a person having minimum Post-Graduate qualification with at least five years' experience in Industries

2. Literature survey in case of seminar is based on the broader area of interest in recent developments and for dissertation it should be focused mainly on identified problem.

3. At least 4-5 hours of course on Research Methodology should be conducted which includes Literature Survey, Problems Identification, Analysis and Interpretation of Results and Technical Paper Writing in the beginning of 3rd Semester.

Subject Code	Subject Name	Credits
SPD 301	Dissertation (I)	12
SPD401	Dissertation (II)	15

Guidelines for Assessment of Dissertation I

o Dissertation I should be assessed based on following points

   ƒ Quality of Literature survey and Novelty in the problem
   ƒ Clarity of Problem definition and Feasibility of problem solution
   ƒ Relevance to the specialization
   ƒ Clarity of objective and scope

o Dissertation I should be assessed through a presentation by a panel of Internal examiners appointed by the Head of the Department/Institute of respective Programme.

Guidelines for Assessment of Dissertation II

o Dissertation II should be assessed based on following points
   ƒ Quality of Literature survey and Novelty in the problem
   ƒ Clarity of Problemdefinition and Feasibility of problem solution
   ƒ Relevance to the specialization or current Research / Industrial trends
   ƒ Clarity of objective and scope
   ƒ Quality of work attempted
   ƒ Validation of results
   ƒ Quality of Written and Oral Presentation

o Dissertation II should be assessed through a presentation jointly by Internal and External Examiners appointed by the University of Mumbai Students should publish at least one paper based on the work in reputed International / National Conference (desirably in Refereed Journal)