Syllabus and Rules and Regulations

for

B. Tech Minor Degree

(in addition to existing Major Degree)

in

Electronics and Communication Engineering

2022-2023 onwards

In the ECE Department

NATIONAL INSTITUTE OF TECHNOLOGY DELHI

(An autonomous Institute under the aegis of Ministry of Education, Govt. of India)

Rules and Regulations for the Proposed Minor Degree Programme

1. All B. Tech students will may opt for the minor degree in the ECE department as per their interest.

2. ECE department is providing minor degree through three different **bouquets of specializations**. Their names and detailed curriculum are attached herewith in the Annexures.

3. The above bouquet of specialization will contain completely different courses/ newly innovative courses with a completely new course code, in comparison to our existing ongoing curriculum (major degree).

4. Students have to opt for a minimum of 4 theory courses and 1 project course for a minor degree i.e. minimum 18 credits to opt for a minor degree in ECE discipline.

5. All such above theory courses for the minor degree will be of (L-T-P = 3-0-2 = 4 credits i.e. theory + lab courses.

6. The SGPA and CGPA calculation will also be completely different for a major and minor degree, with no mapping or no correlation.

7. Separate grade sheets for the minor degrees will be issued like the existing major degree.

8. To commence with the provision of Major and Minor Degrees will be applicable for the students studying in the 5th Semester only from the Academic Year 2022-23. Upcoming 3dr year/ 5th semester Students, while registering for the 5th semester can choose this option.

9. Students studying in the 7th Semester in the Academic Year 2022-23 are not eligible for Major and Minor Degrees.

10. Minor Degree is not mandatory for the students. It is optional for only those students who are willing to do it.

11. The students can opt for the courses for Minor Degree from the 5th semester to the 8th semester with not more than 2 courses in a semester.

12. For a Minor degree, the students can opt for a maximum of two courses through online modes such as MOOC/ NPTEL, etc.

13. In case, the student opts for online courses (as mentioned in the previous point), the Department as per the academic calendar and prevailing norms will do the evaluation.

14. Subjects, listed in the 8th semester will be purely online modes such as MOOC/ NPTEL, etc. However, the Department as per the academic calendar and prevailing norms will do the evaluation.

Credit Requirement

Sl. No.	Category of Courses	Credits offered in the Present Major Degree	Minimum Credits to be Earned through Minor Degree (in addition to the major degree)
1.	Basic Sciences	---	---
2.	Departmental Core	---	---
3.	Other Engineering	---	---
4.	Humanities and Social Sciences	---	---
5.	Elective	24	16
6.	Open Elective	---	---
7.	Project	02	02
8.	Mandatory Courses	---	---

Minimum Credits Required for Award of Minor Degree = 18 (in addition to their Major degree)

Bouquet of Specializations

Specialization in MEMS and Nano-electronics:

Course Code	Course Name	L	T	P	Credit
ECBB 601	Introduction to MEMS Technology	3	0	2	4
ECBB 602	NEMS and Nano-electronics	3	0	2	4
ECBB 603	Fabrication and Micromachining	3	0	2	4
ECBB 604	Analog/ RF applications of MEMS	3	0	2	4
ECBB 605	Advanced Nano-electronics	3	0	2	4
ECPB 601	Project	0	0	0	2

Specialization in Computational Information Processing:

Course Code	Course Name	L	T	P	Credit
ECBB 606	Digital Information Processing System	3	0	2	4
ECBB 607	Digital Visual Processing	3	0	2	4
ECBB 608	Statistical Analysis and Computing	3	0	2	4
ECBB 609	Applied Game Theory	3	0	2	4
ECBB 610	Block chain and It's Application	3	0	2	4
ECPB 601	Project	0	0	0	2

Specialization in SoC Design & IOT:

Course Code	Course Name	L	T	P	Credit
ECBB 611	Real Time Embedded System	3	0	2	4
ECBB 612	Digital IC Design	3	0	2	4
ECBB 613	System on Programmable Chip Design	3	0	2	4
ECBB 614	Cloud Computing & Machine Learning	3	0	2	4
ECBB 615	Introduction to IoT System Design	3	0	2	4
ECBB 616	Digital Signal and Image Processing	3	0	2	4
ECBB 617	Real Time Signal Processing	3	0	2	4
ECPB 601	Project	0	0	0	2

Curriculum in Detail

Course No.:	**Open Course (Yes/No)**	**HM Course (Yes/No)**	**DC (Y/N)**	**DE (Y/N)**	
ECBB 601					
Type of Course	Theory				
Course Title	**Introduction to MEMS Technology**				
Course Objectives:	This course introduced the basic concept of MEMS technology along with various structures and applications.				
Semester	**Autumn:**		**Spring:**		
	Lecture	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
Contact Hours	3	0	0	3	36
Prerequisite course code as per proposed course numbers	NIL				
Equivalent course codes as per proposed course and old course	NIL				
Overlap course codes as per proposed course numbers	NIL				

Text Books:		
1.	Title	MEMS and NEMS systems devices and structures
	Author	E. S. Lyshevski
	Publisher	CRC press
	Edition	2001
2.	Title	MEMS and Microsystems: Design and Manufacture
	Author	Tai-ran Hsu
	Publisher	Tata McGraw-Hill
	Edition	2008
3.	Title	Microsystem Design
	Author	S. Senturia
	Publisher	Kluwer Academic Publishers
	Edition	2005
	Title	An Introduction to Microelectromechanical Systems Engineering
4.	Author	Nadim Maluf, K. Williams
	Publisher	Artech House
	Edition	2004
Contents	**Unit I:** **Introduction:** Classical scaling in CMOS, Moore's Law - Clean room concept, Evolution of Microsensors & MEMS, The Intrinsic Characteristics of MEMS, Miniaturization, Microelectronics Integration, Micromachined Micro sensors& MEMS applications: Mechanical, Inertial, Biological, Chemical, Acoustic, Integrated Smart Sensors	

	Unit II: MEMS Materials, Properties of MEMS Materials, Silicon-Compatible Material System, Other Materials and Substrates Important Material Properties and Physical Effects, Applications and Markets,
	Unit III: Devices: Sensors and Actuators, Introduction to Electrostatic Sensors and Actuators, MEMS Transducers
	Unit IV: MEM Structures, Microactuators:- Piezoelectric, chemical, Thermopneumatic, electrostatic and electromagnetic microactuators, MEMS Simulators and different FEA tools,, MEMS Applications in Life Sciences
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%

Course No.:	**Open Course (Yes/No)**	**HM Course (Yes/No)**	**DC (Y/N)**	**DE (Y/N)**	
ECBB 602					
Type of Course	Theory				
Course Title	**NEMS and Nano-electronics**				
Course Coordinator					
Course Objectives:	The Nano-electronics shows the technology issues beyond 65 nm with new proposed structures. The studies also helps to understand the pro's and con's of different materials while using for new nano devices.				
Semester	**Autumn:**		**Spring:**		
	Lecture	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
Contact Hours	3	0	0	3	36
Prerequisite course code as per proposed course numbers	NIL				
Equivalent course codes as per proposed course and old course	NIL				
Overlap course codes as per proposed course numbers	NIL				

Text Books:

1.	Title	MEMS and NEMS systems devices and structures
	Author	E. S. Lyshevski
	Publisher	CRC press
	Edition	2001
2.	Title	Fundamentals of Modern VLSI devices
	Author	Y. Taur and T. Ning
	Publisher	Cambridge University
	Edition	2008
3.	Title	MOS (Metal Oxide Semiconductor) Physics and Technology
	Author	Nicollian and J. R. Brews
	Publisher	Wiley Publishers
	Edition	2005

Contents

Unit I:

Issues in scaling MOS transistors: Short channel effects, Description of a typical 65 nm CMOS technology, Role of interface quality and related process techniques, Gate oxide thickness, scaling trend, SiO2 vs High-k gate dielectrics, Integration issues of high-k, Interface states, bulk charge, band offset, stability, reliability - Qbd high field, possible candidates, CV and IV techniques, Transport in Nano MOSFET, velocity saturation, ballistic transport, injection velocity, velocity overshoot, Metal gate transistor : Motivation, requirements, Integration Issues.

	Unit II: Non classical MOS transistor: Requirements, and Novel devices SOI - PDSOI and FDSOI, Ultrathin body SOI - double gate transistors, integration issues. Vertical transistors – Fin FET and Cylindrical gate FET. Novel devices: Tunnel FET, Negative-Capacitance (NC) FET. Metal source/drain junctions - Properties of schottky junctions on Silicon, Germanium and compound semiconductors –Work function pinning.
	Unit III: Germanium Nano MOSFETs: strain, quantization, Advantages of Germanium over Silicon, PMOS versus NMOS. Compound semiconductors: Compound semiconductors MOSFETs in the context of channel quantization and strain, Hetero structure MOSFETs, exploiting novel materials, strain, quantization. Emerging nano materials: CNT, Graphene, Nanotubes, nanorods and other nano-structures
	Unit IV: Microelectromechanical Systems, Devices, and Structures, NEMS Architectures, Nano-systems, Quantum Mechanics, and Mathematical Model. Modelling of Micro- and Nanoscale Electromechanical Systems, Devices, and Structures
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%

Course No.:	Open Course (Yes/No)	HM Course (Yes/No)	DC (Y/N)	DE (Y/N)	
ECBB 603					
Type of Course	Theory				
Course Title	**Fabrication and Micromachining**				
Course Coordinator					
Course Objectives:	This course gives the insight into the fabrication of MEMS techniques. This course also provides the knowledge about the bulk micromachining of MEMS and packaging.				
Semester	**Autumn:**		**Spring:**		
	Lecture	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
Contact Hours	3	0	0	3	36
Prerequisite course code as per proposed course numbers	NIL				
Equivalent course codes as per proposed course and old course	NIL				
Overlap course codes as per proposed course numbers	NIL				
Text Books:					
1.	Title	Introductory MEMS, Fabrication and Applications			
	Author	Thomas M. Adams, Richard A. Layton			
	Publisher	Springer			
	Edition	2010			
2.	Title	Fundamentals of MICROFABRICATION: The Science of Miniaturization			
	Author	Marc J. Madou			
	Publisher	CRC press			
	Edition	2001			
Contents	**Unit I:** Silicon growth, Miller indices, Oxidation, Oxidation kinetics, PVD: vacuum fundamentals, thermal evaporation, sputtering, Other additive techniques: CVD, Electrodeposition, Spin coating, wafer bonding, Silicon Ingot manufacturing,				
	Unit II: Photoresists: positive and negative, Working with resist: applying photoresist, exposure and pattern transfer, development and post-treatment, Masks, Resolution in contact, proximity and projection printing, Sensitivity and resist profiles, Mask alignment, Permanent resistes.				
	Unit III: Bulk micromachining: Wet chemical etching, Dry etching, Surface micromachining: Surgace micromachining processes, Problems with surface micromachining, Lift off, Process integration: a surface micromaching example, designing a good MEMS process flow.				
	Unit IV: Function of packaging, Packaging levels, Packaging requirements				

	particular to MEMS,
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%

Course No.:	**Open Course (Yes/No)**	**HM Course (Yes/No)**	**DC (Y/N)**	**DE (Y/N)**	
ECBB 604					
Type of Course	Theory				
Course Title	**Analog/RF Applications of MEMS**				
Course Coordinator					
Course Objectives:	This course offers the in-depth knowledge of Analog /RF MEMS along with their application. The course also provide insight into wireless RF MEMS and Mechanical transducers.				
Semester	**Autumn:**		**Spring:**		
	Lecture	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
Contact Hours	3	0	0	3	36
Prerequisite course code as per proposed course numbers	NIL				
Equivalent course codes as per proposed course and old course	NIL				
Overlap course codes as per proposed course numbers	NIL				

Text Books:		
1.	Title	RF MEMS: Theory, Design, and Technology
	Author	GABRIEL M. REBEIZ
	Publisher	Wiley, 2003
	Edition	2003
2.	Title	RF MEMS Circuit Design for Wireless Communications Héctor
	Author	J. De Los Santos
	Publisher	Artech House
	Edition	London (2002)
3.	Title	MEMS and NEMS Systems, Devices, and Structures
	Author	Sergey Edward Lyshevski
	Publisher	CRC Press
	Edition	2001
Contents	**Unit I:** RF MEMS Configurations, Comparison of MEMS Switches with GaAs PIN Diode and Transistor Switches, Application Areas of RF MEMS, Integration of RF MEMS with Silicon and GaAs, Electronics, Linearity and Intermodulation Products, Power Handling and Reliability	
	Unit II: Introduction: Wireless Standards, Systems, and Architectures, Power- and Bandwidth-Efficient Wireless Systems Challenges, MEMS-Based Wireless Appliances Enable Ubiquitous Connectivity	
	Unit III: The Resonant MEMS Switch, Capacitors, Inductors, MEMS Microswitch Arrays, Reconfigurable Antennas, Tunable Dipole Antennas, Filters	
	Unit IV: Mechanical Transducers, Radiation transducers, Thermal transducers,	

	magnetic transducers, chemical and biological transducers, microfluidic devices
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%

Course No.:	**Open Course (Yes/No)**	**HM Course (Yes/No)**	**DC (Y/N)**	**DE (Y/N)**	
ECBB 605					
Type of Course	Theory				
Course Title	**Advanced Nanoelectronics**				
Course Coordinator					
Course Objectives:	This course introduces the concept of 3D technology with the already implemented FinFET devices. This course provides the knowledge of different efficient architectures for improved CMOS performance.				
Semester	**Autumn:**		**Spring:**		
	Lecture	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
Contact Hours	3	0	0	3	36
Prerequisite course code as per proposed course numbers	NIL				
Equivalent course codes as per proposed course and old course	NIL				
Overlap course codes as per proposed course numbers	NIL				

Text Books:		
1.	Title	Advanced Nanoelectronics: Post silicon Materials and devices
	Author	M. M. Hussain
	Publisher	Wiley-VCH
	Edition	2019
2.	Title	Junctionless Field Effect transistors Simulations
	Author	S. Sahay, M.K Jagdish,
	Publisher	Wiley-VCH
	Edition	2019
Contents	**Unit I:** FinFET Technology, 3D Integrated Circuit Technology, Neuromorphic Computing Technology, Quantum Computing Technology, Nanowire Field-Effect Transistors, General Scaling Laws Leading to Nanowire Architectures, Nanowire Growth and Device Fabrication Approaches, State-of-the-Art Nanowire Devices	
	Unit II: 2D Materials Transistor and Device Technology, Graphene Electronics for Radiofrequency Applications, MoS2 Devices for Digital Application	
	Unit III: Introduction, Process Integration for Ge MOS Devices, State-of-the-Art Ge CMOS with Recessed Channel and S/D, Carbon Nanotube Logic Technology, Fundamentals of Carbon Nanotube, Perspective of CNT-Based Logic Technology. Tunnel Field-Effect Transistors: The Fundamentals, Modelling of TFETs, Beyond Low-Power Computation	
	Unit IV: Energy-Efficient Computing with Negative Capacitance, Experimental Demonstration of Negative Capacitance FETs, How a Negative Capacitance Gate Oxide Leads to Sub-60-Millivolt/Decade Switching, Direct Measurement of	

	Negative Capacitance in Ferroelectric, How a Ferroelectric Material Acts as a Negative Capacitor, Spin-Based Devices for Logic, Memory, and Non-Boolean, Architectures, Spin-Based Devices, Nano-magnetic Devices
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%

Course No.:	**Open Course (Yes/No)**	**HM Course (Yes/No)**	**DC (Y/N)**	**DE (Y/N)**	
ECBB 606	**No**	**No**	**Yes**	**No**	
Type of Course	Theory				
Course Title	**Digital Information Processing System**				
Course Coordinator					
Course Objectives:	To introduce students basic techniques in designing and implementing digital signal processing systems. Introduce efficient computation method of discrete Fourier transform. To study the advanced signal processing techniques and application. Apply the signal processing algorithms for a wide range of applications.				
Semester	**Autumn:**		**Spring:**		
	Lecture	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
Contact Hours	3	0	0	3	36
Prerequisite course code as per proposed course numbers	NIL				
Equivalent course codes as per proposed course and old course	NIL				
Overlap course codes as per proposed course numbers	NIL				

Text Books:		
1.	Title	Digital Signal Processing: A Computer-Based Approach
	Author	S. K. Mitra
	Publisher	McGraw-Hill
	Edition	Third edition, 2006
2.	Title	Discrete-Time Signal Processing
	Author	A.Oppenheim and R. Schafer
	Publisher	Prentice Hall
	Edition	Second edition, 1999
3.	Title	Digital Signal Processing: Principles, Algorithms and Applications
	Author	J. Proakis, D. Manolakis
	Publisher	Prentice-Hall
	Edition	Fourth edition, 2006
Reference Book		
1.	Title	Theory and Application of Digital Signal Processing
	Author	L.R. Rabiner and B. Gold
	Publisher	Phi Learning
	Edition	First edition, 2008

Contents	**Unit I** **Introduction to DSP and Z-Transform** Introduction to Digital signal processing, Discrete time signals and sequence operations, properties. Discrete time signals and systems, their properties, Quantization, sampling, Nyquist–Shannon sampling theorem. Z-transforms by summation of left, right, and two-sided sequences, Regions of convergence and Z-transform properties, Inverse Z-transform, Stability and causality, Solution of Difference Equations using Z-transform.
	Unit II **Discrete and fast Fourier Transforms** Definition of Discrete Fourier Transform (DFT) and relation to Z-transform, Properties of the DFT, Matrix Formulation of the DFT and IDFT, Linear and periodic convolution using the DFT, Zero padding, spectral leakage, resolution and windowing in the DFT. Efficient computation of DFT, FFT algorithms, Decimation in time domain and decimation in frequency domain algorithms.
	Unit III **FIR and IIR Filter Structures** Structures and properties of FIR and IIR filters, IIR-Direct, parallel and cascade realizations, FIR–Direct and cascade realizations, Coefficient quantization effects in digital filters.
	Unit IV **Design of FIR and IIR filters** Digital filter design, Finite impulse response (FIR)filters-Window design techniques, Kaiser Window design technique, Equi-ripple approximations, Infinite impulse response (IIR) filters-Bilinear transform method, Examples of bilinear transform method.
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%

Course No.:	**Open Course (Yes/No)**	**HM Course (Yes/No)**	**DC (Y/N)**	**DE (Y/N)**	
ECBB 607	**No**	**No**	**Yes**	**No**	
Type of Course	Theory				
Course Title	**Digital Visual Processing**				
Course Coordinator					
Course Objectives:	Overview of digital visual processing (DVP) field; understand the fundamental DVP algorithms and implementation; gain experience in applying image processing algorithms to real problems.				
Semester	**Autumn:**		**Spring:**		
	Lecture	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
Contact Hours	3	0	0	3	36
Prerequisite course code as per proposed course numbers	NIL				
Equivalent course codes as per proposed course and old course	NIL				
Overlap course codes as per proposed course numbers	NIL				

Text Books:		
1.	Title	Digital image processing
	Publisher	Pearson
	Edition	Fourth edition, 2006
	Author	Rafael c. Gonzalez
2.	Title	Fundamentals of digital image processing
	publisher	PHI
	Edition	Third edition
	Author	Anil k jain
Contents	**UNIT I:** **Digital image fundamentals and Visual Filtering:** Visual perception Visual sensing and acquisition, sampling and quantization, basic relationship between pixels and their neighbourhood properties; Image enhancement in spatial domain: Gray-level transformations, histogram equalization. Spatial filters- averaging, order statistics; Edge detection first and second derivative filters, Sobel, Canny, Laplacian and Laplacian-of Gaussion masks. Filtering in frequency domain: One and two-dimensional DFT, properties of 2-D DFT, periodicity properties, convolution and correlation theorems, Fast Fourier Transforms, Smoothing and sharpening filtering in frequency domain, ideal and Butterworth filters, homomorphic filtering.	

	UNIT II: **Visual Information restoration:** Degradation/ restoration, process, noise models, restoration in presence of noise-only spatial filtering, linear position-invariant degradations, estimating the degradation function, inverse filtering, Wiener filtering, constrained least squares filtering, geometric transformations. **Color image processing**: Color models RGB, HSI, YUV, pseudo-color image processing, full-colorimage, processing, color transformation, color segmentation, noise in, color images.
	UNIT III: Morphological image Processing: Basic operations- dilation, erosion, opening, closing, Hit-Miss transformations, Basic morphological algorithms- boundary extraction, region filling, connected components, convex hull, thinning, thickening, skeletons, pruning, extensions to gray-scale morphology.
	UNIT IV: **Image segmentation:** Edge linking and boundary detection, Hough transforms, graph-theoretic techniques, global and adaptive thresholding, Region based segmentation, Segmentation by morphological watersheds, motion base segmentation; Texture Analysis: Co-occurrence matrix, Gabor filter motion base segmentation; Texture Analysis: Co-occurrence matrix, Gabor filter. motion base segmentation; Texture Analysis: Co-occurrence matrix, Gabor filter.
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%

Course no:	**Open course (YES/NO)**	**HM Course (Y/N)**	**DC (Y/N)**	**DE (Y/N)**	
ECBB 608	No	No	No	No	
Type of Course	Theory				
Course Title	**Statistical Analysis and Computing**				
Course Coordinator					
Course objectives:	This course aims to familiarize several algorithms for processing and estimation of random signals. This course teaches filtering methods for stochastic processes and covers the spectral analysis.				
Semester	**Autumn: Yes**		**Spring: No**		
Contact Hours	**Lecture**	**Tutorial**	**Practical**	**Credits**	**Contact Hours**
Contact Hours	3	0	0	3	**Contact Hours**
Prerequisite course code as per proposed course numbers					**Prerequisite course code as per proposed course numbers**
Equivalent course codes as per proposed course and old course					**Equivalent course codes as per proposed course and old course**
Overlap course codes as per proposed course numbers					**Overlap course codes as per proposed course numbers**
Text Books:					**Text Books:**

1.	Title	Discrete Random Signals and Statistical Signal Processing
	Author	Charles W. Therrien
	Publisher	Prentice Hall Signal Processing Series
	Edition	2004
2.	Title	Statistical Digital Signal Processing and Modeling
	Author	M. H. Hayes
	Publisher	John Wiley & Sons, Inc
	Edition	2004
3.	Title	Statistical and Adaptive Signal Processing
	Author	D.G. Manolakis, V.K. Ingle and S.M. Kogon
	Publisher	McGraw Hill,
	Edition	2000
Reference Books:		
1	Title	Adaptive Filter Theory
	Author	Simon Haykin
	Publisher	Prentice Hall

	Edition	1996
Contents	**UNIT I:** **Introduction to the stochastic phenomenon:** Distribution and density functions, moments, independent, uncorrelated and orthogonal random variables; Vector-space representation of Random variables, Schwarz Inequality Orthogonality principle in estimation, Central Limit theorem, Random processes, wide-sense stationary processes, autocorrelation and auto-covariance functions, Spectral representation of random signals, Wiener Khinchin theorem Properties of power spectral density, Gaussian Process and White noise process, Linear System with random input, Spectral factorization theorem and its importance, innovation process and whitening filter, Random signal modelling: MA(q), AR(p), ARMA(p,q) models.	
	UNIT II: **Parameter Estimation Theory:** Principle of estimation and applications, Properties of estimates, unbiased and consistent estimators, Minimum Variance Unbiased Estimates (MVUE), Cramer Rao bound, Efficient estimators; Criteria of estimation: the methods of maximum likelihood and its properties; Baysean estimation: Mean square error and MMSE, Mean Absolute error, Hit and Miss cost function and MAP estimation.	
	UNIT III: **Estimation of signal in presence of white Gaussian Noise:** Linear Minimum Mean-Square Error (LMMSE) Filtering: Wiener Hoff Equation, FIR Wiener filter, Causal IIR Wiener filter, Non-causal IIR Wiener filter, Linear Prediction of Signals, Forward and Backward Predictions, Levinson Durbin Algorithm, Lattice filter realization of prediction error filters.	
	UNIT IV: **Adaptive Filtering:** Principle and Application, Steepest Descent Algorithm Convergence characteristics; LMS algorithm, convergence, excess mean square error, Leaky LMS algorithm; Application of Adaptive filters; RLS algorithm, derivation, Matrix inversion Lemma, Initialization, tracking of non-stationarity. State-space model and the optimal state estimation problem, discrete Kalman filter, continuous-time Kalman filter, extended Kalman filter. filter. motion base segmentation; Texture Analysis: Co-occurrence matrix, Gabor filter.motion base segmentation; Texture Analysis: Co-occurrence matrix, Gabor filter.	
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%	

Course no:	Open course (YES/NO)	HM Course (Y/N)	DC (Y/N)	DE (Y/N)
ECBB 609	No	**Yes**	**No**	**No**
Type of Course				
Course Title	**Applied Game Theory**			
Course Coordinator				
Course objectives:	To produce optimal decision-making of independent and competing skills in students in a strategic setting.			

Semester	**Autumn: Yes**		**Spring: No**		
	Lecture	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
Contact Hours	3	0	0	3	**42**
Prerequisite course code as per proposed course numbers					
Prerequisite Credits					
Equivalent course codes as per proposed course and old course					
Overlap course codes as per proposed course numbers					

Text Books:

1.	Title	An Introduction to Game Theory
	Author	Martin J. Osborne
	Publisher	Oxford University Press
	Edition	2003
2.	Title	Game Theory And Mechanism Design

	Author	Y. Narahari
	Publisher	World Scientific Publishing Co Pt Ltd
	Edition	2020
Reference Books:		
	Title	Essentials of Game Theory
	Author	Kevin Leyton-Brown and Yoav Shoham
	Publisher	Morgan & Claypool Publishers
	Edition	2008
	Proposed Syllabus	
Content	**UNIT I:** **Introduction:** Introduction, overview, uses of game theory, some applications and examples, and formal definitions of: the normal form, payoffs, strategies, pure strategy and mixed strategy Nash equilibrium, dominant strategies.	
	UNIT II: **Alternate Solution Concepts for Games:** Iterative removal of strictly dominated strategies, minimax strategies and the minimax theorem for zero-sum game, correlated equilibria.	
	UNIT III: **Extensive-Form Games:** Perfect information games: trees, players assigned to nodes, payoffs, backward Induction, subgame perfect equilibrium, introduction to imperfect-information games, mixed versus behavioral strategies.	
	UNIT IV: **Repeated Bayesian and Coalitional Games:** Repeated prisoners dilemma, finite and infinite repeated games, limited-average versus future-discounted reward, folk theorems, stochastic games and learning. General definitions, ex ante/interim Bayesian Nash equilibrium. Transferable utility cooperative games, Shapley value, Core, applications.	
Course Assessment	**Theory**: Continuous Evaluation 25% Mid Semester 25% End Semester 50%.	

Course no:	Open course (YES/NO)	HM Course (Y/N)	DC (Y/N)	DE (Y/N)
ECBB 610	No	**Yes**	**No**	**No**
Type of Course				
Course Title	**Block chain and its application**			
Course Coordinator				
Course objectives:	to provide conceptual understanding of how blockchain technology can be used to innovate and improve business processes.			
POs				

Semester	**Autumn: Yes**		**Spring: No**		
	Lecture	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
Contact Hours	3	0	0	3	**42**
Prerequisite course code as per proposed course numbers					
Prerequisite Credits					
Equivalent course codes as per proposed course and old course					
Overlap course codes as per proposed course numbers					

Text Books:

1.	Title	Mastering Bitcoin: Unlocking Digital Cryptocurrencies
	Author	Andreas M. Antonopoulos
	Publisher	O'Reilly
	Edition	1st
2.	Title	Blockchain

	Author	Melanie Swan
	Publisher	O'Reilly
	Edition	January 2015
	Proposed Syllabus	
Content	**UNIT I:** **Introduction:** Blockchain Components and Concepts, Smart Contracts. Overview of the current financial system and its drawbacks. Advantages of Blockchain as an alternate financial system. Cryptography, Hash Functions, Public Key Cryptography and Digital Signature.	
	UNIT II: **Bitcoin Fundamentals:** Bitcoin's block structure, Consensus and mining processes in Bitcoin Bitcoin Trading, Scripting language in Bitcoin.	
	UNIT III: **Permissioned Blockchain and Hyperledger Fabric:** Permissioned Blockchain Architecture, RAFT Consensus, Byzantine General Problem, Practical Byzantine Fault Tolerance. Key Frameworks and Tools, Membership and Identity Management, Hyper ledger composer.	
	UNIT IV: **Application of Blockchain:** Blockchain's implications on Traditional Business, Practical use-cases of Blockchain in Finance, Industry and Governance.	
Course Assessment	**Theory**: Continuous Evaluation 25% Mid Semester 25% End Semester 50%.	

Course no:	Open course(YES/NO)	HM Course(Y/N)	DC(Y/N)	DE(Y/N)
ECBB 611	No	**Yes**	**No**	**No**
Type of Course	Theory			
Course Title	**Real Time Embedded Systems**			
Course Coordinator				
Course objectives:	• To expose the students to the fundamentals of embedded system design. • To enable the students to understand and use embedded computing platform. • To introduce networking principles in embedded devices. • To learn real time characteristics in embedded system design. • To explore system design techniques.			

Semester	**Autumn: Yes**		**Spring: No**		
	Lecture	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
Contact Hours	3	0	0	3	**42**
Prerequisite course code as per proposed Course numbers					
Prerequisite Credits					
Equivalent course AS per proposed course and old course					
Overlap course codes as per proposed course numbers					

Text Books:		
1.	Title	Computers as Components: Principles of Embedded Computing System Design
	Author	Wayne Wolf
	Publisher	Morgan Kaufman Publishers 2012
	Edition	3rd Edition
2.	Title	Real-Time systems
	Author	Jane.W.S. Liu
	Publisher	Pearson Education Asia, 2001
	Edition	1st Edition
Reference Books:		
1.	Title	Real-Time Systems
	Author	C. M. Krishna and K. G. Shin

	Publisher	McGraw-Hill, 1997
	Edition	1st Edition
2.	Title	Embedded System Design: A Unified Hardware/Software Introduction
	Author	Frank Vahid and Tony Givargis
	Publisher	John Wiley & Sons, 2002
	Edition	1st Edition
Content	**UNIT I: Embedded Processors** Embedded Computers, Characteristics of Embedded Computing Applications, Challenges in Embedded Computing system design, Embedded system design process- Requirements, Specification, Architectural Design, Designing Hardware and Software Components, System Integration, Formalism for System Design- Structural Description, Behavioral Description, and Design Example: Model Train Controller, ARM processor-processor and memory organization.	
	UNIT II: Embedded Computing Platform Data operations, Flow of Control, SHARC processor- Memory organization, Data operations, Flow of Control, parallelism with instructions, CPU Bus configuration, ARM Bus, SHARC Bus, Memory devices, Input/output devices, Component interfacing, designing with microprocessor development and debugging, Design Example: Alarm Clock.	
	UNIT III: Networks Distributed Embedded Architecture- Hardware and Software Architectures, Networks for embedded systems- I2C, CAN Bus, SHARC link supports, Ethernet, Myrinet, Internet, Network-Based design- Communication Analysis, system performance Analysis, Hardware platform design, Allocation and scheduling, Design Example: Elevator Controller.	
	UNIT IV: Real-Time Characteristics and System Design Techniques Clock driven Approach, weighted round robin Approach, Priority driven Approach, Dynamic Versus Static systems, effective release times and deadlines, Optimality of the Earliest deadline first (EDF) algorithm, challenges in validating timing constraints in priority driven systems, Off-line Versus On-line scheduling. Design Methodologies, Requirement Analysis, Specification, System Analysis and Architecture Design, Quality Assurance, Design Example: Telephone PBX- System Architecture, Ink jet printer- Hardware Design and Software Design, Personal Digital Assistants, Set-top Boxes.	
Course Assessment	**Theory**: Continuous Evaluation 25%, Mid Semester 25%, End Semester 50%.	

Course no:	Open course(YES/NO)	HM Course(Y/N)	DC(Y/N)	DE(Y/N)
ECBB 612	No	**Yes**	**No**	**No**
Type of Course	Theory			
Course Title	**Digital Integrated Circuit Design**			
Course Coordinator				
Course objectives:	To introduce the transistor level design of all digital building blocks common to all CMOS microprocessors, network processors, digital backend of all wireless systems etc.,			
B				
Semester	**Autumn: Yes**		**Spring: No**	

	Lecture	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
Contact Hours	3	0	0	3	**45**
Prerequisite course code as per proposed Course numbers					
Prerequisite Credits					
Equivalent course code as per course and old course					
Overlap course codes as pre proposed course numbers					

Text Books:		
1.	Title	Digital Integrated Circuit: A design perspective
	Author	J. M. Rabaey, A. Chandrakasan, B. Nikolic
	Publisher	Pearson Education, Delhi-2005
	Edition	2nd Edition
2.	Title	CMOS VLSI Design
	Author	Weste, Neil HE, and David Money Harris
	Publisher	Pearson/Addison Wesley, 2010. Geiger
	Edition	1st Edition
Reference Books:		
1.	Title	Low power design methodologies
	Author	J. M. Rabaey., and MassoudPedram, eds
	Publisher	Springer Science & Business Media, 2012
	Edition	1st Edition
2.	Title	CMOS Digital Integrated Circuits Analysis and Design
	Author	Sung-Mo Kang & Yusuf Leblebici
	Publisher	McGraw-Hill, 1998.

	Edition	1st Edition
Content	**UNIT I:** **MOS Transistor Principles and CMOS Inverter** Introduction ,MOS Capacitor Threshold Voltage, MOS(FET) Transistor, Short Channel Transistor , CMOS Inverter Construction , Voltage Transfer Characteristics , Load line Analysis , Noise Margin Analysis , Pass Transistor ,Inverter : Transient Response, Dynamic power, short circuit power ,Leakage power and Transistor stacks .	
	UNIT II: **Combinational Logic Circuits** Implementing any Boolean logic function , Gate sizing , Logic gate capacitance , Gate delay , parasitic Delay, Gate delay with load capacitance ,path delay calculation and optimization Psuedo NMOS Logic , Domino Logic and Weak Keeper , Transmission Gate Logic , Gate Sizing for Large Circuits .	
	UNIT III: **Arithmetic Building Blocks** Ripple Adder Introduction , Full Adder Circuit Implementation , Full Adder optimization ,Carry Select Adder , Two' Complement Arithmetic , Array Multiplier : Timing Analysis , Carry Save Multiplier : Signed Multiplication	
	UNIT IV: Sequential Logic Circuits Introduction to pipelining , Time Borrowing , Master slave Flip flop , Flip-Flop Timing Parameters , Alternate Circuit Implementation , Clock overlap , C2MOS Flip-Flop, Flip-flop characterization , Max and Min Delay of Flop-Flop Based system , Flip-Flop Min Delay Constraints , Latch –Max and Min Delay Constraints , Latch –Timing Analysis With Skew.	
Course Assessment	**Theory**: Continuous Evaluation 25% Mid Semester 25% End Semester 50%.	

Course no:	Open course (YES/NO)	HM Course(Y/N)	DC(Y/N)	DE(Y/N)
ECBB 613	No	**Yes**	**No**	**No**
Type of Course	Theory			
Course Title	**System-on-Programmable Chip Design**			
Course Coordinator				
Course objectives:	To understand the concepts of System on Chip Design methodology and Design flow.			
Semester	**Autumn: Yes**		**Spring: No**	

	Lecture	Tutorial	Practical	Credits	Total Teaching Hours
Contact Hours	3	0	0	3	**45**
Prerequisite course code as per proposed Course numbers					
Prerequisite Credits					
Equivalent course codes as per proposed course and old course					
Overlap course codes as per proposed course numbers					

Text Books:

1.	Title	Computer system Design: System on-Chip
	Author	Michael J. Flynn, Wayne Luke
	Publisher	Wiley-India, 2012
	Edition	16/e
2.	Title	On Chip Communication Architectures: System on Chip Interconnect
	Author	Sudeep Pasricha, Nikhil Dutt
	Publisher	Morgan Kaufmann Publishers, 2008.

	Edition	1st Edition
Reference Books:		
1.	Title	Computers as Components: Principles of Embedded Computing System Design
	Author	W.H.Wolf
	Publisher	Elsevier, 2008.
	Edition	1st Edition
2.	Title	A Practical Introduction to Hardware/Software Co-design
	Author	Patrick Schaumont
	Publisher	Springer, 2012
	Edition	2nd Edition
3.	Title	Modern VLSI Design: IP Based Design
	Author	Wayne Wolf
	Publisher	Prentice-Hall India, Fourth edition, 2009
	Edition	1st Edition
Content	**UNIT I: System-level Design** Driving Forces for SoC - Components of SoC - Design flow of SoC- Hardware/Software nature of SoC - Design Trade-offs - SoC Applications, Processor selection -Concepts in Processor Architecture: Instruction set architecture (ISA), Elements in Instruction Handing-Robust processors: Vector processor, VLIW, Superscalar, CISC, RISC— Processor evolution: Soft and Firm processors, Custom-Designed processors- on-chip memory.	
	UNIT II: Interconnection On-chip Buses: basic architecture, topologies, arbitration and protocols, Bus standards: AMBA, Core Connect, Wishbone, Avalon - Network-on chip: Architecture-topologies-switching strategies- routing algorithms-flow control, Quality-of-Service-Reconfigurability in communication architectures.	
	UNIT III: IP based system design Introduction to IP Based design, Types of IP, IP across design hierarchy, IP life cycle, Creating and using IP - Technical concerns on IP reuse – IP integration – IP evaluation on FPGA prototypes.	
	UNIT IV: SoC Implementation soc Testing Study of processor IP, Memory IP, wrapper Design - Real-time operating system (RTOS), Peripheral interface and components, High-density FPGAs - EDA tools used for SOC design.	
Course Assessment	**Theory**: Continuous Evaluation 25% Mid Semester 25% End Semester 50%.	

Course no:	Open course (YES/NO)	HM Course (Y/N)	DC (Y/N)	DE (Y/N)
ECBB 614	No	**Yes**	**No**	**No**
Type of Course	Theory			
Course Title	**Cloud Computing and Machine Learning**			
Course Coordinator				
Course objectives:				

Semester	**Autumn: Yes**		**Spring: No**		
	Lecture	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
Contact Hours	3	0	0	3	**42**
Prerequisite course code as per proposed course numbers					
Prerequisite Credits					
Equivalent course codes as per proposed course and old course					
Overlap course codes as per proposed course numbers					

Text Books:		
1.	Title	Internet of Things: A Hands-on Approach
	Author	Arshdeep Bahga and Vijay Madisetti

	Publisher	Universities Press
	Edition	2014
2.	Title	Mastering in Cloud Computing
	Author	Rajkumar Buyya, Christian Vecchiola and ThamariSelvi S
	Publisher	McGraw Hill Education (India) Private Limited,
	Edition	2013
Reference Books:		
1.	Title	The Internet of Things: Enabling Technologies, Platforms, and Use Cases
	Author	Pethuru Raj and Anupama C. Raman
	Publisher	Taylor and Francis (CRC Press)
	Edition	2017
Content	**UNIT I: Introduction to cloud computing** Cloud computing at a Glance – Historical Development – Building Cloud Computing Environments – Computing Platform and Technologies – Principles of Parallel and Distributed Computing – Elements of parallel and Distributed Computing.	
	UNIT II: IoT Architecture & Technologies The second module "IoT Architecture & Technologies" focuses on the functionality and characteristics of the IoT architecture layers as well as the characteristics of IoT technologies, which include WSN (Wireless Sensor Networks), IoT cloud computing, IoT R&D (Research & Development), and IoT hardware technologies. Further details are provided in the descriptions of the characteristics of IoT sensors types, actuator types, and RFID types as well as the functionality and characteristics of IoT device platforms, which include the Arduino, Raspberry Pi, and Beagle Board products. Next, a comparison of the representative IoT developer platform products is presented, which include the Raspberry Pi, Raspberry Pi 3 Model B, Beagle Board, Beagle bone Black, and the Arduino systems Uno R3 (for entry and general purpose), Yun (for IoT), and Lilypad (for wearable).	
	UNIT III: **Introduction to Machine Learning (ML) and its application with IOT and cloud computing** Introduction to Supervised ML and Unsupervised ML, Mathematical Background for ML-Matrix ops Probability Theory(Bayes' Theorem), Statistical knowledge for ML- Mean, Median, Mode, Tools required for development -Anaconda, Jupyter NB, ML libraries Explained: Scipy Numpy, Matplotlib, ML Glossary- Variable types, k-fold, CV, AUC, F1 score, Overfitting/Underfitting, Generalization, Data split & hyper parameter training, Data wrangling using Pandas, Preprocessing data and feature engineering, Exploratory Data analysis using Visualisation, Scikit-learn Library for ML, Classification-Regression, Different types of Regression-Linear and Logistic, Decision tree Algorithms, Naive Bayes' Classification, KNN Classification,	
	UNIT IV: Application of Machine Learning (ML) with IOT and cloud computing Revisiting Python, Real-world code exercises Clustering Introduction, k-means clustering, SVM and Artificial Neural Networks.	
Course	**Theory**: Continuous Evaluation 25%, Mid Semester 25%	

Assessment	End Semester 50%.

Course no:	Open course (YES/NO)	HM Course(Y/N)	DC(Y/N)	DE(Y/N)
ECBB 615	No	**Yes**	**No**	**No**
Type of Course				
Course Title	**Introduction to IOT System Design**			
Course Coordinator				
Course objectives:	**1.** Outline the various IOT communication models & terminologies with networking and protocol considerations.			

Semester	**Autumn: Yes**		**Spring: No**		
	Lecture	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
Contact Hours	3	0	0	3	**42**
Pre requisite course code as per proposed Course numbers					
Prerequisite Credits					
Equivalent course code as per proposed course and old course					
Overlap course codes as per proposed course numbers					

Text Books:

1.	Title	Internet of Things: A Hands-on Approach
	Author	Arshdeep Bahga and Vijay Madisetti
	Publisher	Universities Press
	Edition	2014

Reference Books:		
1.	Title	The Internet of Things: Enabling Technologies, Platforms, and Use Cases
	Author	Pethuru Raj and Anupama C. Raman
	Publisher	Taylor and Francis (CRC Press)
	Edition	2017
Content	**UNIT I:** **IOT Comm. Models and Terminologies :** Introduction to IOT (People Connecting to Things, Things Connecting to Things, Definition of IOT, History of IOT), IOT Components (Sensors & Actuators, Things, Communications bNetworks, The Internet, Protocol Stack), IOT Communication Models, IOT Applications, IOT Companies, Baseline Technologies (Machine to Machine(M2M)Communication, Web of Things (WOT)), Address Crunch in IOT, IOT Terminologies (IOT Node, LAN, MAN & WAN, IOT Gateway & Proxy), IOT Network Configuration (Gateway Prefix Allotment, Impact of Mobility on Addressing, Concept of Tunneling Multi-homing), IPv4 Versus IPv6.	
	UNIT II: **IOT Networking Protocols :** Introduction to IOT Networking, Networking Standards and Technologies (Network Access & Physical Layer, Internet Layer, Transport Layer, The application layer), IOT Networking Protocols, Network Access and Physical layer IoT Network Technologies ((LPWAN (Low Power Wide Area Network), Cellular, Bluetooth Low Energy (BLE), RFID, NFC, Zigbee, Wifi, Ethernet), Internet layer IoT network technologies (IPv6, 6LoWPAN, and RPL), Application layer IoT network technologies (HTTP, HTTPS, MQTT, AMQP, and XMPP), IoT networking considerations and challenges, IoT Platforms Capabilities.	
	UNIT III: **IoT supported Hardware platforms (Arduino & NodeMcu)**: Introduction to Arduino (Different Arduino boards, Arduino Uno board description and its pin configuration, Arduino IDE and program uploading, different functions related to GPIOs and special functions (PWM and Serial communication), Interrupts, Introduction to NodeMcu (board description & pin configuration), Integration of NodeMcu in Arduino IDE,Interfacing with Arduino/NodeMcu using processing language (LED, Switch, Seven Segment, LCD, DC Motor, Relay, IR, LDR and DHT11 sensor), use of simulator and compiler, Configuring Node Mcu as Wi fi Module (ESP8266).	
	UNIT IV: **Web Development and Interaction with Apps &Cloud Platform:** Basics of HTML programming (elements, attributes, paragraph, image etc), CSS, Tables and Forms, Creating local server and webserver using Node Mcu, Creating a Web page to control actuator Wi fi, Introduction to Thing speak Cloud Platform (creating account and configure channel for live data feed, Concept of Write and Read APIs), Case Studies: Controlling an actuator connected to Node Mcu using remote web interface via cloud, Visualization of sensor data on the cloud and integrate them onto the webpage, Introduction to IFTTT & Ada fruit IO (creating account and configuration), Controlling home appliances using Google Assistant AI application via IFTTT and Adafruit I/O (MQTT protocol).	
Course	Continuous Evaluation 25%	

Assessment	Mid Semester 25% End Semester 50%.	

Course no:	Open course (YES/NO)	HM Course (Y/N)	DC(Y/N)	DE(Y/N)
ECBB 616	No	**Yes**	**No**	**No**
Type of Course				
Course Title	**DIGITAL SIGNAL & IMAGE PROCESSING**			
Course Coordinator				
Course objectives:	**1.** Recall the principles of various transform techniques like Z, Chirp Z, Hilbert, and Discrete Fourier transform and Fast Fourier Transform.			

Semester	**Autumn: Yes**		**Spring: No**		
	Lecture	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
Contact Hours	3	0	0	3	**42**
Pre requisite course code as pre proposed Course numbers					
Prerequisite Credits					
Equivalent course code as per proposed course and old course					
Overlap course codes as perproposed course numbers					

Text Books:

1.	Title	Digital Signal Processing, Principles, Algorithms and Applications
	Author	J.G. Proakis& D.G. Manolakis
	Publisher	PHI
	Edition	2012

Refrence Books:

1.	Title	Adaptive Signal Processing: Next Generation Solutions
	Author	Tulay Adah and Simon Haykins
	Publisher	Wiley India
	Edition	2012
Content	**UNIT I:** **Review of Digital Signal Processing:** Review of discrete-time sequences and systems, Linear Shift Invariant (LSI) systems. Causality and stability Criterion, FIR & IIR re Presentation Z-Transform Discrete Fourier Transform (DFT), Fast Fourier Transform (FFT) algorithms using decimation in time and decimation in frequency techniques, Chirp Z-Transform, Hilbert Transform and applications.	
	UNIT II: **Design of IIR and FIR Filters**: Digital filter specifications, selection of filter type, and filter order, FIR filter design; using windowing Techniques, Fourier Series and frequency sampling method, Design of IIR Filters Using Butterworth, Chebyshev and Elliptic Approximations, Frequency Transformation Techniques; approximation of derivatives, Impulse invariant method, Bilinear transformation, Structures for IIR Systems – Direct Form I & II, Cascade, Parallel, Lattice & Lattice-Ladder Structures, Structures For FIR Systems – Direct , Cascade, Parallel, Lattice & Lattice ladder Structures.	
	UNIT III: **Multi rate Digital Signal Processing:** Decimation & Interpolation, Sampling rate conversion, Identities, polyphase decomposition, General polyphase framework for Decimator and Interpolator, Multistage decimator and Interpolator, Efficient transversal structure for Decimator and Interpolator, FIR and IIR structure for Decimator, Filter design for FIR decimator and Interpolator, Application of Multi rate Signal processing.	
	UNIT IV: **Adaptive Filters:** Introduction, Application of adaptive filters, correlation structure, FIR Weiner Filter, Adaptive Direct-form FIR filters Adaptive Lattice-Ladder filters, Introduction to linear prediction, linear prediction and autoregressive modelling	
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%.	

Course No.:	**Open Course (Yes/No)**	**HM Course (Yes/No)**	**DC (Y/N)**	**DE (Y/N)**	
ECBB 617	**No**	**No**	**Yes**	**No**	
Type of Course	Theory				
Course Title	**Real-time Signal Processing**				
Course Coordinator					
Course Objectives:	To provide the overview of signal processing techniques.				
Semester	**Autumn:**		**Spring:**		
	Lecture	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
Contact Hours	3	0	0	3	36
Prerequisite course code as per proposed course numbers	NIL				
Equivalent course codes as per proposed course and old course	NIL				
Overlap course codes as per proposed course numbers	NIL				

Text Books:		
1.	Title	Digital Signal Processing: A Computer-Based Approach
	Author	S. K. Mitra
	Publisher	McGraw-Hill
	Edition	Third edition, 2006
2.	Title	Discrete-Time Signal Processing
	Author	A.Oppenheim and R. Schafer
	Publisher	Prentice Hall
	Edition	Second edition, 1999
3.	Title	Digital Signal Processing: Principles, Algorithms and Applications
	Author	J. Proakis, D. Manolakis

	Publisher	Prentice-Hall
	Edition	Fourth edition, 2006
1.	Title	Theory and Application of Digital Signal Processing
	Author	L.R. Rabiner and B. Gold
	Publisher	Phi Learning
	Edition	First edition, 2008
Contents	**Unit I** **The Discrete Fourier Transforms** Discrete Fourier transform, properties of DFT. Frequency domain sampling, Frequency analysis of signals using the DFT. DFT of discrete time signals, Relation between DFT and Z-transform. IDFT.	
	Unit II **Fast Fourier Transforms** Direct computation of DFT, Need of efficient computation of DFT, Radix-2 Decimation in time domain and decimation in frequency domain algorithms (DIT-FFT and DIF-FFT), Linear filtering methods based on DFT Goertzel Algorithms	
	Unit III **Implementation of Discrete time systems** FIR Systems- Direct Form-I, Direct Form-II, Cascade, Parallel structure IIR Systems- Direct Form, Cascade, Linear phase structure, Frequency sampling structure	
	Unit IV **Design of IIR and FIR filters** Design of digital IIR digital filters from ANALOG filters, Impulse invariance method and bilinear transformation method. frequency transformations. Design of digital FIR filters using window method	
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%	