Visvesvaraya Technological University, Belagavi.
PhD Coursework Courses – 2018 (Electronics and Communication Engineering)
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<td>DIGITAL VLSI DESIGN</td>
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<td>16EVE152</td>
<td>NANOELECTRONICS</td>
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<tr>
<td>8</td>
<td>16EIE23</td>
<td>Process Control Instrumentation</td>
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<td>16ESP21</td>
<td>Image Processing and Machine Vision</td>
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<td>16ESP421</td>
<td>Array Signal Processing</td>
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<td>5</td>
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<td>Micro Electro Mechanical Systems</td>
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<td>9</td>
<td>16EIE151</td>
<td>PLCs AND INDUSTRIAL AUTOMATION</td>
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<td>ANTENNA THEORY AND DESIGN</td>
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<td>Speech and Audio Processing</td>
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<td>3</td>
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<td>Statistical Signal Processing</td>
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<td>Detection and Estimation</td>
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<td>Design of Analog and Mixed Mode VLSI Circuits</td>
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<tr>
<td>6</td>
<td>16EVE23</td>
<td>Advances in VLSI Design</td>
</tr>
<tr>
<td>7</td>
<td>16EIE22</td>
<td>Design of Power Converters</td>
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**GROUP-5**

<table>
<thead>
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<tbody>
<tr>
<td>1</td>
<td>16ECS153</td>
<td>OPTICAL COMMUNICATION AND NETWORKING</td>
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<td>2</td>
<td>16ECS151</td>
<td>ADVANCED COMPUTER NETWORKS</td>
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<tr>
<td>3</td>
<td>16ECS254</td>
<td>CRYPTOGRAPHY AND NETWORK SECURITY</td>
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<td>4</td>
<td>16ESP24</td>
<td>Biomedical Signal Processing</td>
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<td>5</td>
<td>16ESP253</td>
<td>Pattern Recognition</td>
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<td>6</td>
<td>16EVE24</td>
<td>Real Time Operating System</td>
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<td>7</td>
<td>16ECS424</td>
<td>Real Time Systems</td>
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<td>8</td>
<td>16EVE153</td>
<td>ASIC DESIGN</td>
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<td>9</td>
<td>16EVE13</td>
<td>ADVANCED EMBEDDED SYSTEM</td>
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<td>10</td>
<td>16EVE14</td>
<td>LOW POWER VLSI DESIGN</td>
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<td>11</td>
<td>16EIE424</td>
<td>Industrial Drive</td>
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**GROUP-6**

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<tr>
<td>1</td>
<td>16ECS252</td>
<td>MULTIMEDIA OVER COMMUNICATION LINKS</td>
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<td>2</td>
<td>16ECS24</td>
<td>RF AND MICROWAVE CIRCUIT DESIGN</td>
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<td>3</td>
<td>16ESP41</td>
<td>Adaptive Signal Processing</td>
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<td>4</td>
<td>16ESP152</td>
<td>Multirate Systems and Filter Banks</td>
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<td>5</td>
<td>16ESP153</td>
<td>MODERN SPECTRAL ANALYSIS &amp; ESTIMATION</td>
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<tr>
<td>6</td>
<td>16ECS423</td>
<td>Communication System Design using DSP Algorithms</td>
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<tr>
<td>7</td>
<td>16ECS154</td>
<td>SIMULATION, MODELLING AND ANALYSIS</td>
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<td>8</td>
<td>16EVE22</td>
<td>VLSI Testing</td>
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<td>16EVE254</td>
<td>SoC Design</td>
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<td>16EVE423</td>
<td>High Speed VLSI Design</td>
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<td>16EVE421</td>
<td>CMOS RF Circuit Design</td>
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<td>16EVE252</td>
<td>VLSI Design for Signal Processing</td>
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**PhD Coursework Courses – 2018 (Electronics and Communication Engineering)**

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<thead>
<tr>
<th>01</th>
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<tr>
<td></td>
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<td>**Exam Hours:**03  **Exam Marks:**100</td>
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<tr>
<td><strong>Module -1 Digital Modulation Schemes:</strong></td>
<td>Representation of Digitally Modulated Signals, Memoryless Modulation Methods-PAM, Phase Modulation, QAM, Multidimensional Signalling, Signalling Schemes with memory: CPFSK, CPM, MSK, OQPSK. Transmit PSD for Modulation Schemes (Chapter 3: 3.1,3.2,3.3, 3.4.1 and 3.4.2 of Text).</td>
<td></td>
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<tr>
<td><strong>Module -2 Optimum Receivers for AWGN channels:</strong></td>
<td>Waveform and Vector channel models, Waveform and Vector AWGN channels- Optimal detection, Implementation, Optimal Detection and Error Probability for Band limited signaling. Optimal detection and error probability for power limited signaling. Non Coherent Detection (without derivations) (Chapter 4: 4.1, 4.2 - 4.2.1, 4.2.2, 4.3, 4.4, 4.5.1, 4.5.2, eqn 4.5.45 to 4.5.47, 4.5.5 up to eqn 4.5.62 of Text).</td>
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<tr>
<td><strong>Module -3 Multichannel and Multicarrier Signaling:</strong></td>
<td>Multichannel Communications in an AWGN channel, Multicarrier Communications in AWGN channel (Chapter 11- 11.1, 11.2-1 to 11.2-5 of Text). <strong>Synchronization:</strong> Signal Parameter estimation, Carrier Phase Estimation, Symbol Timing Recovery (Chapter 5- 5.1 to 5.3 of Text).</td>
<td></td>
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<tr>
<td><strong>Module -4 Digital Communication through band-limited channels:</strong></td>
<td>Characterization of Band-limited channels, Optimum Receiver for channels with ISI and AWGN, Linear equalization, Decision feedback equalization (Chapter 9: 9.1,9.3- 9.3.1, 9.3.2, 9.4- 9.4.1, 9.4.2, 9.4.4, 9.4.5, 9.5- 9.5.1, 9.5.3 of Text). Adaptive equalization: Adaptive linear equalizer, adaptive decision feedback equalizer, Adaptive equalization of Trellis -coded signals (Chapter 10: 10.1, 10.2, 10.3 of Text).</td>
<td></td>
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</tr>
<tr>
<td><strong>Module -5 Spread spectrum signals for digital communication:</strong></td>
<td>Model of spread spectrum digital communication system, Direct sequence spread spectrum signals, Frequency hopped spread spectrum signals, CDMA, Time hopping SS, Synchronization of SS systems (Chapter 12 of Text).</td>
<td></td>
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</tbody>
</table>

**Question paper pattern:**
- The question paper will have ten questions.
- Each full question consists of 20 marks.
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.

The students will have to answer 5 full questions, selecting one full question from each module.

**Reference: Book:**

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<tr>
<td>Exam Hours: 03</td>
<td>Exam Marks: 100</td>
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**Module -1 Multirate Digital Signal Processing:** Introduction, decimation by a factor 'D', Interpolation by a factor 'I', sampling rate conversion by a factor 'I/D'. Implementation of sampling rate conversion, Multistage implementation of sampling rate conversion, Applications of multirate signal processing, Digital filter banks, two channel quadrature mirror filter banks, M-channel QMF bank. (Text 1)

**Module -2 Linear prediction and Optimum Linear Filters:** Random signals, Correlation Functions and Power Spectra, Innovations Representation of a Stationary Random Process. Forward and Backward Linear Prediction. Solution of the Normal Equations The Levinson-Durbin Algorithm. Properties of the Linear Prediction-Error Filters. (Text 1)


**Parametric Methods for Power Spectrum Estimation:** Relationship between the auto correlation and the model parameters, Yule and Walker methods for the AR Model Parameters, Burg Method for the AR Model parameters, Unconstrained least-squares method for the AR Model parameters, Sequential estimation methods for the AR Model parameters, ARMA Model for Power Spectrum Estimation. (Text 1)

**Module -5 WAVELET TRANSFORMS:** The Age of Wavelets, The origin of Wavelets, Wavelets and other reality transforms, History of wavelets, Wavelets of the future.

**Continuous Wavelet and Short Time Fourier Transform:** Wavelet Transform, Mathematical preliminaries, Properties of wavelets.

**Discrete Wavelet Transform:** Haar scaling functions, Haar wavelet function, Daubechies Wavelets. (Chapters 1, 3 & 4 of Text 2)

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<tr>
<td>-2</td>
<td>Fault Detection by Path Sensitizing, Detection of Multiple Faults, Failure-Tolerant Design, Quadded Logic, Reliable Design and Fault Diagnosis Hazards: Fault Detection in Combinational Circuits.</td>
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<tr>
<td>-3</td>
<td>Fault-Location Experiments, Boolean Differences, Limitations of Finite – State Machines, State Equivalence and Machine Minimization, Simplification of Incompletely Specified Machines.</td>
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<td>Exam Marks:100</td>
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Module -1 Introduction to Synthesis and Optimization: Design of Microelectronics circuits, Computer aided Synthesis and Optimization.

Hardware Modeling: HDLs for Synthesis, Abstract models, Compilation and Behavioral Optimization. (Text1: Topics from Chap. 1,3).

Module -2 Graph theory for CAD for VLSI: Graphs, Combinatorial Optimization, Graph Optimization problems and Algorithms, Boolean Algebra and Applications.


Module -4 Sequential Logic Optimization:


Resource Sharing and Binding: Sharing and Binding for Resource dominated circuits, Sharing and Binding for General Circuits, Concurrent Binding and Scheduling, Resource sharing and Binding for Non – Scheduled Sequencing Graphs. (Text1: Chap. 5, 6).

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<th>Sensors and Transducers</th>
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**Exam Hours:** 03  **Exam Marks:** 100

**Module -1 Measurements and Instrumentation of Transducers:** Measurements, Basic method of measurement, Generalized scheme for measurement systems, Errors, Classification of errors, error analysis, Statistical methods, Sensor, Transducer, Classification of transducers, Basic requirement of transducers. (Text 1).


**Module -3 Measurement of Force & Torque:** Introduction, Force measuring sensor – Load cells – column types devices, proving rings, cantilever beam, pressductor. Hydraulic load cell, Electronic weighing system. Torque measurement: Absorption type, transmission type, stress type & deflection type. (Text 2)

**Module -4 Measurement of Pressure:** Introduction, Diaphragms, Other elastic elements, Transduction methods – potentiometric device, strain gauge transducer, variable reluctance, LVDT type, variable capacitance device, force balance transducer with analysis, thin-film pressure transducers, piezoelectric pressure transducer, pressure multiplexer, pressure calibration. (Text 2).


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<th>Module</th>
<th>Course Title</th>
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<tr>
<td>Module 1</td>
<td>Automotive Fundamentals, the Systems Approach to Control and Instrumentation</td>
<td>Use Of Electronics In The Automobile, Antilock Brake Systems, (ABS), Electronic steering control, Power steering, Traction control, Electronically controlled suspension. (Chap.1 and 2 of Text)</td>
</tr>
<tr>
<td>Module 2</td>
<td>Automotive instrumentation Control</td>
<td>Sampling, Measurement and signal conversion of various parameters. (Chap. 4 of Text)</td>
</tr>
<tr>
<td>Module 4</td>
<td>Vehicle Motion Control and Automotive diagnostics</td>
<td>Cruise control system, Digital cruise control, Timing light, Engine analyzer, On-board and off-board diagnostics, Expert systems. Stepper motorbased actuator, Cruise control electronics, Vacuum – antilock braking system, Electronic suspension system Electronic steering control, Computer-based instrumentation system, Sampling and Input/output signal conversion, Fuel quantity measurement, Coolant temperature measurement, Oil pressure measurement, Vehicle speed measurement, Display devices, Trip-Information-Computer, Occupant protection systems. (Chap. 8 and 10 of Text)</td>
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08  16EIE12  Group-1  ADVANCED CONTROL SYSTEMS

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<tr>
<td><strong>Module -1 Digital Control Systems:</strong> Review of Difference equations, Z — transforms and Inverse Z transforms, The Z-transfer function (Pulse transfer function), The Z -Transform Analysis of Sampled data Control Systems, The Z and S-domain relationship, Stability analysis (Jury’s Stability Test and Bilinear Transformation)(Text 1, Text 2).</td>
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</tr>
<tr>
<td><strong>Module -2 State Models &amp; Solution of State equations:</strong> State models for Linear Continuous Time and Linear Discrete Time systems, Diagonalization, Solution of State Equations (for both Continuous and Discrete Time systems), Relevant problems (Text1).</td>
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<tr>
<td><strong>Module -3 State Feedback Systems:</strong> Concepts of Controllability and Observability (for both Continuous and Discrete Time systems), Pole Placement by State Feedback (for both continuous and discrete Time systems), Observer System (Full order and Reduced order observers for both Continuous and Discrete Time systems), Relevant problems(Text 1, Text 2).</td>
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</tr>
<tr>
<td><strong>Module -4 Regulators:</strong> Dead beat Control by State Feedback, Optimal control problems using State Variable approach, State regulator and Output regulator, Concepts of Model Reference Adaptive Control (MRAC)(Text 1, Text 2).</td>
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**Reference Books:**
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<tr>
<th>Module</th>
<th>Description</th>
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<tbody>
<tr>
<td>1</td>
<td>The Wireless channel: Physical modeling for wireless channels, Input/output model of wireless channels, Time and frequency response, Statistical models. (Text 1).</td>
</tr>
<tr>
<td>2</td>
<td>Point-to-Point Communication, Detection diversity and channel uncertainty: Detection in Rayleigh fading channels, Time diversity, Antenna diversity, Frequency diversity, Impact of the channel uncertainty. (Text 1).</td>
</tr>
<tr>
<td>3</td>
<td>Diversity: Introduction Micro-diversity, Micro-diversity and Simulcast combination of signals, Error probability in fading channels with diversity reception, Transmit diversity. (Chap. 13 of Text2).</td>
</tr>
<tr>
<td>4</td>
<td>Capacity of wireless channel: AWGN channel capacity, Resources of AWGN channel, Linear time invariant Gaussian channel, Capacity of fading channels. (Text 1).</td>
</tr>
<tr>
<td>5</td>
<td>MIMO Systems: Introduction, Space diversity and system based on space diversity, Smart antenna systems and MIMO, MIMO based system architecture; MIMO exploits multipath, Space time processing, Antenna considerations for MIMO. MIMO channel modeling, MIMO channel measurements, MIMO channel capacity, CDD, Space time coding, advantages and applications of MIMO, MIMO application in 3G.(Chap. 15 of Text 3).</td>
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<tbody>
<tr>
<td><strong>Module -1</strong> The image, its representations and properties: Image representations a few concepts, Image digitization, Digital image properties, Color images.</td>
<td></td>
</tr>
<tr>
<td><strong>Module -2</strong> Image Pre-processing: Pixel brightness transformations, geometric transformations, local pre-processing.</td>
<td></td>
</tr>
<tr>
<td><strong>Module -3</strong> Segmentation: Thresholding; Edge-based segmentation – Edge image thresholding, Edge relaxation, Border tracing, Hough transforms; Region – based segmentation – Region merging, Region splitting, Splitting and merging, Watershed segmentation, Region growing post-processing.</td>
<td></td>
</tr>
<tr>
<td><strong>Module -4</strong> Shape representation and description: Region identification; Contour-based shape representation and description – Chain codes, Simple geometric border representation, Fourier transforms of boundaries, Boundary description using segment sequences, B-spline representation; Region-based shape representation and description – Simple scalar region descriptors, Moments, Convex hull.</td>
<td></td>
</tr>
<tr>
<td><strong>Module -5</strong> Mathematical Morphology: Basic morphological concepts, Four morphological principles, Binary dilation and erosion, Skeletons and object marking, Morphological segmentations and watersheds.</td>
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- The students will have to answer 5 full questions, selecting one full question from each module.

**Reference Books:**


**Text Book:**

Visvesvaraya Technological University, Belagavi.
PhD Coursework Courses – 2018  (Electronics and Communication Engineering)
As per 2017 Regulation

<table>
<thead>
<tr>
<th>03</th>
<th>16ESP22</th>
<th>Group-2</th>
<th>DSP System Design</th>
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<tbody>
<tr>
<td>Exam Hours:</td>
<td>03</td>
<td>Exam Marks:</td>
<td>100</td>
</tr>
</tbody>
</table>

**Module -1** Introduction to popular DSP CPU Architecture – CPU Data Paths and Control-Timers-Internal Data/Program Memory-External Memory Interface-Programming –Instruction set and Addressing Modes-Code Composer Studio-Code Generation Tools –Code Composer Studio Debugtools –Simulator (Text 1)

**Module -2** Sharck Digital Signal Processor- A popular DSP from Analog Devices - Sharck/ Tiger Sharck/ Blackfin (one of them) - Architecture – IOP Registers - Peripherals - Synchronous Serial Port Interrupts - Internal/External/Multiprocessor Memory Space - Multiprocessing - Host Interface - Link Ports. (Text 2)

**Module -3** Digital Signal Processing Applications-FIR and IIR Digital Filter Design, Filter Design Programs using MATLAB- Fourier Transform: DFT, FFT programs using MATLAB (Text 1)

**Module -4** Real Time Implementation –Implementation of Real Time Digital Filters using DSP-Implementation of FFT Applications using DSP – DTMF Tone Generation and Detection (Text 1)

**Module -5** Current trends- Current trend in Digital Signal Processor or DSP Controller- Architecture and their applications. (Text 1)

Question paper pattern:
- The question paper will have ten questions.
- Each full question consists of 20 marks.
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.

The students will have to answer 5 full questions, selecting one full question from each module.

**Text Books:**

**Reference Books:**
### Digital Signal Compression

**Module -1**
- Introduction: Compression techniques, Modeling & coding, Distortion criteria, Differential Entropy, Rate Distortion Theory, Vector Spaces, Information theory, Models for sources, Coding–uniquely decodable codes, Prefix codes, Kraft McMillan Inequality. Quantization: Quantization problem, Uniform Quantizer, Adaptive Quantization, Non-uniform Quantization; Entropy coded Quantization, Vector Quantization, LBG algorithm, Tree structured VQ, Structured VQ. Variations of VQ–Gain shape VQ, Mean removed VQ, Classified VQ, Multistage VQ, Adaptive VQ, Trellis coded quantization.

**Module -2**

**Module -3**

**Module -4**

**Module -5**

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**Question paper pattern:**
- The question paper will have ten questions.
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The students will have to answer 5 full questions, selecting one full question from each module.

**Text Book:**

**Reference Books:**
Visvesvaraya Technological University, Belagavi.
PhD Coursework Courses – 2018 (Electronics and Communication Engineering)
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<table>
<thead>
<tr>
<th>05</th>
<th>16EVE12</th>
<th>Group-2</th>
<th>DIGITAL VLSI DESIGN</th>
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</thead>
<tbody>
<tr>
<td>Module -2 MOS Inverters-Static Characteristics: Introduction, Resistive-Load Inverter, Inverters with n_Type MOSFET Load.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
| Question paper pattern:  
  - The question paper will have ten questions.  
  - Each full question consists of 20 marks.  
  - There will be 2 full questions (with a maximum of four sub questions) from each module.  
  - Each full question will have sub questions covering all the topics under a module. |
| The students will have to answer 5 full questions, selecting one full question from each module. |
| Text Books:  
| Reference Books:  
## Module -1 Introduction

## Module -2 Languages and Compilation
*Design Cycle, Languages, HDL, High Level Compilation, Low level Design flow, Debugging Reconfigurable Computing Applications.*

## Module -3 Implementation
*Integration, FPGA Design flow, Logic Synthesis.*

## Module -4 Partial Reconfiguration Design

## Module -5 Signal Processing Applications
*Reconfigurable computing for DSP, DSP application building blocks, Examples: Beamforming, Software Radio, Image and video processing, Local Neighbourhood functions, Convolution.*

**System on a Programmable Chip:** Introduction to SoPC, Adaptive Multiprocessing on Chip. (Text 2).

### Question paper pattern:
- The question paper will have ten questions.
- Each full question consists of 20 marks.
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.

The students will have to answer 5 full questions, selecting one full question from each module.

### Text Books:

### Reference Books:
# NANO ELECTRONICS

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<thead>
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<th>Exam Hours: 03</th>
<th>Group-2</th>
<th>Exam Marks: 100</th>
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</thead>
<tbody>
<tr>
<td><strong>Module -1 Introduction:</strong> Overview of nanoscience and engineering. Development milestones in microfabrication and electronic industry. Moore’s law and continued miniaturization, Classification of Nanostructures. Electronic properties of atoms and solids: Isolated atom, Bonding between atoms, Giant molecular solids, Free electron models and energy bands, crystaline solids, Periodicity of crystal lattices, Electronic conduction, effects of nanometer length scale, Fabrication methods: Top down processes, Bottom up processes methods for templating the growth of nanomaterials, ordering of nanosystems (Text 1).</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Module -2 Characterization:</strong> Classification, Microscopic techniques, Field ion microscopy, scanning probe techniques, diffraction techniques: bulk and surface diffraction techniques (Text 1).</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Module -3 Characterization:</strong> spectroscopy techniques: photon, radiofrequency, electron, surface analysis and dept profiling: electron, mass, Ion beam, Reflectrometry, Techniques for property measurement: mechanical, electron, magnetic, thermal properties.</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Inorganic semiconductor nanostructures:</strong> overview of semiconductor physics. Quantum confinement in semiconductor nanostructures: quantum wells, quantum wires, quantum dots, super-lattices, band offsets, electronic density of states (Text 1).</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Module -4 Fabrication techniques:</strong> requirements of ideal semiconductor, epitaxial growth of quantum wells, lithography and etching, cleaved-edge over growth, growth of vicinal substrates, strain induced dots and wires, electrostatically induced dots and wires, Quantum well width fluctuations, thermally annealed quantum wells, semiconductor nanocrystals, colloidal quantum dots, self assembly techniques.</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Physical processes:</strong> modulation doping, quantum hall effect, resonant tunneling, charging effects, ballistic carrier transport, Inter band absorption, intraband absorption, Light emission processes, phonon bottleneck, quantum confined stark effect, nonlinear effects, coherence and dephasing, characterization of semiconductor nanostructures: optical electrical and structural (Text 1).</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Module -5 Methods of measuring properties:</strong> Atomic, crystallography, microscopy, spectroscopy (Text 2).</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Applications:</strong> Injection lasers, quantum cascade lasers, singlephoton sources, biological tagging, optical memories, coulomb blockade devices, photonic structures, QWIP’s, NEMS, MEMS (Text 1).</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Question paper pattern:**
- The question paper will have ten questions.
- Each full question consists of 20 marks.
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**Text Books:**

**Reference Book:**
**Visvesvaraya Technological University, Belagavi.**  
**PhD Coursework Courses – 2018 (Electronics and Communication Engineering)**  
**As per 2017 Regulation**

<table>
<thead>
<tr>
<th>08</th>
<th>16EIE23</th>
<th>Group-2</th>
<th>Process Control Instrumentation</th>
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<tbody>
<tr>
<td><strong>Exam Hours:03</strong></td>
<td><strong>Exam Marks:100</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>


**Module -2 DATA ACQUISITION AND CONTROL UNIT:** Hardware and Software- Basic modules, functional modules, DACU capacity expansion, system cables, Integrated assemblies, DACU construction, Data exchange on bus, Software structure, application programming, Programmable control subsystems, Types of automation systems.

**Module -3 DATA COMMUNICATION AND NETWORKING:** Communication network, signal and data transmission, Data communication protocol, Inter process communication, cyber security, Safe and redundant network

**Module -4 FIELDBUS TECHNOLOGY & SAFETY SYSTEMS:** Centralized, remote- input-output, Field bus- input-output, communication, device integration, Other networks. Safety systems introduction, Process and Machine safety management.

**Module -5 MANAGEMENT AND INFORMATION TECHNOLOGY IN INDUSTRIAL PROCESSES:** Introduction, Classification of industrial processes, Manufacturing and utility processes, industrial robotics, operation technology and IT, before and convergence, ISA 95 standard, new developments.

**Question paper pattern:**
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- Each full question consists of 20 marks.
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
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**Text Book:**

**Reference Books:**
Visvesvaraya Technological University, Belagavi.
PhD Coursework Courses – 2018 (Electronics and Communication Engineering)
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<table>
<thead>
<tr>
<th>01</th>
<th>16ECS22</th>
<th>Group-3</th>
<th>ERROR CONTROL CODING</th>
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</thead>
<tbody>
<tr>
<td>Exam Hours:03</td>
<td>Exam Marks:100</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Module -1 Information theory:** Introduction, Entropy, Source coding theorem, discrete memoryless channel, Mutual Information, Channel Capacity Channel coding theorem. (Chap. 5 of Text 1)

**Introduction to algebra:** Groups, Fields, binary field arithmetic, Construction of Galois Fields GF (2m) and its properties, (Only statements of theorems without proof) Computation using Galois field GF (2m) arithmetic, Vector spaces and Matrices. (Chap. 2 of Text 2)

**Module -2 Linear block codes:** Generator and parity check matrices, Encoding circuits, Syndrome and error detection, Minimum distance considerations, Error detecting and error correcting capabilities, Standard array and syndrome decoding, Single Parity Check Codes (SPC), Repetition codes, Self dual codes, Hamming codes, Reed-Muller codes. Product codes and Interleaved codes. (Chap. 3 of Text 2)

**Module -3 Cyclic codes:** Introduction, Generator and parity check polynomials, Encoding of cyclic codes, Syndrome computing and error detection, Decoding of cyclic codes, Error trapping Decoding, Cyclic hamming codes, Shortened cyclic codes. (Chap. 4 of Text 2)

**Module -4 BCH codes:** Binary primitive BCH codes, Decoding procedures, Implementation of Galois field arithmetic, Implementation of error correction. (Chap. 6 of Text 2)

**Reed -Solomon codes.** (Chap. 7 of Text 2)

**Majority Logic decodable codes:** One-step majority logic decoding, One-step majority logic decodable codes, Two-step majority logic decoding, Multiple-step majority logic. (Chap. 8 of Text 2)

**Module -5 Convolution codes:** Convolutional Encoding, Convolutional Encoder Representation, Formulation of the Convolutional Decoding Problem, Properties of Convolutional Codes: Distance property of convolutional codes, Systematic and Nonsystematic Convolutional Codes, Performance Bounds for Convolutional Codes, Coding Gain. Other Convolutional Decoding Algorithms: Sequential Decoding, Feedback Decoding. (Chap. 7 of Text 3)

**Question paper pattern:**
- The question paper will have ten questions.
- Each full question consists of 20 marks.
- There will be 2 full questions (with a maximum of four sub questions) from each module.
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The students will have to answer 5 full questions, selecting one full question from each module.

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PhD Coursework Courses – 2018 (Electronics and Communication Engineering)
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<table>
<thead>
<tr>
<th>Module</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Introduction to Algebra: Groups, Fields, Binary Field Arithmetic, Construction of Galois Field GF (2m) and its basic properties, Computation using Galois Field GF (2m) Arithmetic, Vector spaces and Matrices. Linear Block Codes: Generator and Parity check Matrices, Encoding circuits, Syndrome and Error Detection, Minimum Distance Considerations, Error detecting and Error correcting capabilities, Standard array and Syndrome decoding, Decoding circuits, Reed–Muller codes, Product codes and Interleaved codes.</td>
</tr>
<tr>
<td>2</td>
<td>Cyclic Codes: Introduction, Generator and Parity check Polynomials, Encoding of cyclic codes, Generator matrix for Cyclic codes, Syndrome computation and Error detection, Meggitt decoder, Error trapping decoding, Cyclic Hamming codes, The (23, 12) Golay code, Shortened cyclic codes.</td>
</tr>
<tr>
<td>3</td>
<td>BCH Codes: Binary primitive BCH codes, Decoding procedures, Implementation of Galois field Arithmetic, Implementation of Error correction, Non–binary BCH codes: q–ary Linear Block Codes, Primitive BCH codes over GF (q), Reed–Solomon Codes, Decoding of Non–Binary BCH and RS codes: The Berlekamp-Massey Algorithm.</td>
</tr>
<tr>
<td>4</td>
<td>Majority Logic Decodable Codes: One–Step Majority logic decoding, one–step Majority logic decodable Codes, Multiple–step Majority logic decoding. Convolutional Codes: Encoding of Convolutional codes, Structural properties, Distance properties, Viterbi Decoding Algorithm for decoding, Soft – output Viterbi Algorithm, Stack and Fano sequential decoding Algorithms, Majority logic decoding.</td>
</tr>
<tr>
<td>5</td>
<td>Concatenated Codes &amp; Turbo Codes: Single level Concatenated codes, Multilevel Concatenated codes, Soft decision Multi stage decoding, Concatenated coding schemes with Convolutional Inner codes, Introduction to Turbo coding and their distance properties, Design of Turbo codes. Burst–Error–Correcting Codes: Burst and Random error correcting codes, Concept of Inter–leaving, cyclic codes for Burst Error correction–Fire codes, Convolutional codes for Burst Error correction.</td>
</tr>
</tbody>
</table>

**Question paper pattern:**
- The question paper will have ten questions.
- Each full question consists of 20 marks.
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Visvesvaraya Technological University, Belagavi.
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<table>
<thead>
<tr>
<th>03</th>
<th>16ESP21</th>
<th>Group-3</th>
<th>Image Processing and Machine Vision</th>
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<tbody>
<tr>
<td>Exam Hours:03</td>
<td>Exam Marks:100</td>
<td></td>
<td></td>
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</tbody>
</table>

**Module -1** The image mathematical and physical background: Linearity, The Dirac distribution and convolution, Linear integral transforms, Images as linear systems, *Introduction to linear integral transforms:* 2D Fourier transform, Sampling and the Shannon constraint, Discrete cosine transform, Wavelet transform, Eigen-analysis, Singular value decomposition, Principal component analysis, Other orthogonal image transforms.

**Module -2** Image pre-processing: Scale in image processing, Canny edge detection, Parametric edge models, Edges in multi-spectral images, Pre-processing in frequency domain, Line detection, Corner detection, Maximally stable extremal regions, Image restoration: Degradations that are easy to restore, Inverse filtration, Wiener filtration.

**Module -3** Image segmentation: Threshold detection methods, Optimal thresholding, Multi-spectral thresholding, Edge-based segmentation, Edge image thresholding, Edge relaxation, Border tracing, Border detection as graph searching, Border detection as dynamic programming, Hough transforms, Border detection using border location information, Region construction from borders, Region-based segmentation, Region merging, Region splitting, Splitting and merging, Watershed segmentation, Region growing post-processing, Matching : Matching criteria, Control strategies of matching evaluation issues in segmentation: Supervised evaluation, Unsupervised evaluation.

**Module -4** Advanced segmentation: Mean Shift Segmentation, Active contour models-snakes, Traditional snakes and balloons, Extensions, Gradient vector flow snakes, Geometric deformable models-level sets and geodesic active contours, Fuzzy Connectivity, Contour-based shape representation and description: Chain codes, Simple geometric border representation, Fourier transforms of boundaries, Boundary description using segment sequences, B-spline representation, Other contour-based shape description approaches, Shape invariants.


**Question paper pattern:**
- The question paper will have ten questions.
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The students will have to answer 5 full questions, selecting one full question from each module.

**Text Book:**

**Reference Books:**
Visvesvaraya Technological University, Belagavi.
PhD Coursework Courses – 2018 (Electronics and Communication Engineering)
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<table>
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<tr>
<th>04</th>
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<th>Array Signal Processing</th>
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<tbody>
<tr>
<td><strong>Exam Hours:</strong> 03</td>
<td><strong>Exam Marks:</strong> 100</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Module -2</strong> Wave number-Frequency Space Spatial Sampling: Spatial Sampling Theorem-Nyquist Criteria, Aliasing in Spatial frequency domain, Spatial sampling of multidimensional signals.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Module -3</strong> Sensor Arrays: Linear Arrays, Planar Arrays, Frequency – Wave number Response and Beam pattern, Array manifold vector, Conventional Beam former, Narrowband beam former.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Module -4</strong> Uniform Linear Arrays: Beam pattern in ( \theta ), ( u ) and ( \psi ) -space, Uniformly Weighted Linear Arrays. Beam Pattern Parameters: Half Power Beam Width, Distance to First Null, Location of side lobes and Rate of Decrease, Grating Lobes, Array Steering.</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

**Question paper pattern:**
- The question paper will have ten questions.
- Each full question consists of 20 marks.
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- Each full question will have sub questions covering all the topics under a module.

The students will have to answer 5 full questions, selecting one full question from each module.

**Text Book:**

**Reference Books:**
## Module -1 Introduction and Methodology:
Digital Systems and Embedded Systems, Binary representation and Circuit Elements, Real-World Circuits, Models, Design Methodology.

## Module -2 Number Basics:
Unsigned and Signed Integers, Fixed and Floating-point Numbers.

## Sequential Basics:
Storage elements, Counters, Sequential Data paths and Control, Clocked Synchronous Timing Methodology.

## Module -3 Memories:
Concepts, Memory Types, Error Detection and Correction.

## Implementation Fabrics:
ICs, PLDs, Packaging and Circuit Boards, Interconnection and Signal Integrity.

## Module -4 Processor Basics:
Embedded Computer Organization, Instruction and Data, Interfacing with memory.

## I/O interfacing:
I/O devices, I/O controllers, Parallel Buses, Serial Transmission, I/O software.

## Module -5 Accelerators:
Concepts, case study, Verification of accelerators.

## Design Methodology:
Design flow, Design optimization, Design for test.

### Question paper pattern:
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### Text Book:

### Reference Book:
**Visvesvaraya Technological University, Belagavi.**  
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**As per 2017 Regulation**

<table>
<thead>
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<th>ADVANCED COMPUTER ARCHITECTURE</th>
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<tbody>
<tr>
<td>Exam Hours:03</td>
<td>Exam Marks:100</td>
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<td></td>
</tr>
</tbody>
</table>

**Module -1 Parallel Computer Models:** Classification of parallel computers, Multiprocessors and multicomputers, Multivector and SIMD computers. Program and Network Properties, Conditions of parallelism, Data and resource Dependences, Hardware and software parallelism.

**Module -2.** Program partitioning and scheduling, Grain Size and latency, Program flow mechanisms, Control flow versus data flow, Data flow Architecture, Demand driven mechanisms, Comparisons of flow mechanisms, Principles of Scalable Performance, Performance Metrics and Measures, Parallel Processing Applications, Speedup Performance Laws, Scalability Analysis and Approaches.

**Module -3 Advanced Processors:** Advanced processor technology. Instruction-set Architectures. CISC Scalar Processors, RISC Scalar Processors, Superscalar Processors, VLIW Architectures, Pipelining, Linear pipeline processor, nonlinear pipeline processor, Instruction pipeline design.

**Module -4** Mechanisms for instruction pipelining, Dynamic instruction scheduling, Branch Handling techniques, branch prediction, Arithmetic Pipeline Design, Computer arithmetic principles, Static Arithmetic pipeline, Multifunctional arithmetic pipelines.

**Module -5** Multithread and Dataflow Architecture: Principles of Multithreading, Scalable and Multithreaded Architecture, Data flow Architecture, Symmetric shared memory architecture, distributed shared memory architecture.

Question paper pattern:
- The question paper will have ten questions.
- Each full question consists of 20 marks.
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The students will have to answer 5 full questions, selecting one full question from each module.

**Text Books:**

**Reference Books:**
**Module 1 Verification Guidelines:**
The verification process, basic test bench functionality, directed testing, methodology basics, constrained random stimulus, randomization, functional coverage, test bench components.

**Data Types:**
Built in Data types, fixed and dynamic arrays, Queues, associative arrays, linked lists, array methods, choosing a storage type, creating new types with type def, creating user defined structures, type conversion, Enumerated types, constants and strings, Expression width.

**Module 2 Procedural Statements and Routines:**
Procedural statements, Tasks, Functions and void functions, Task and function overview, Routine arguments, returning from a routine, Local data storage, time values.

**Convert the test bench and design:**
Separating the test bench and design, The interface construct, Stimulus timing, Interface driving and sampling, System Verilog assertions.

**Module 3 Randomization:**

**Module 4 Threads and Interprocess Communication:**
Working with threads, Disabling threads, Interprocess communication, Events, semaphores, Mailboxes, Building a test bench with threads and Interprocess Communication.

**Module 5 Functional Coverage:**
Coverage types, Coverage strategies, Simple coverage example, Anatomy of Cover group and Triggering a Cover group, Data sampling, Cross coverage, Generic Cover groups, Coverage options, Analyzing coverage data, measuring coverage statistics during simulation.

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**Text Book:**

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Visvesvaraya Technological University, Belagavi.
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<table>
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<th>16ELD253</th>
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<th>Micro Electro Mechanical Systems</th>
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<tbody>
<tr>
<td>Exam Hours: 03</td>
<td>Exam Marks: 100</td>
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</tr>
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</table>

Module -1 Overview of MEMS and Microsystems: MEMS and Microsystem, Typical MEMS and Microsystems Products, Evolution of Microfabrication, Microsystems and Microelectronics, Multidisciplinary Nature of Microsystems, Miniaturization, Applications and Markets.


Question paper pattern:
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The students will have to answer 5 full questions, selecting one full question from each module.

**Text Book:**
Tai-Ran Hsu, MEMS and Microsystems: Design, Manufacture and Nanoscale Engineering, 2nd Ed, Wiley.

**Reference Books:**
Visvesvaraya Technological University, Belagavi.

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<tbody>
<tr>
<td>09</td>
<td>16EIE151</td>
</tr>
</tbody>
</table>

Module -1 Introduction to PLC
Technical Definition, Advantages, Characteristic Functions, Chronological Evolution, Types, Unitary PLC, Modular PLC, SMEEi PLC, Medium PLC, Large PLC, Block Diagram Of PLC, Input / Output Section, Processor Section, Power Supply, Memory, Central Processing Unit, Processor Software / Executive Software, Multi-tasking, Languages, Ladder Language.

Bit Logic Instructions: Introduction, Input And Output Contact Program, Symbols, Numbering System Of Inputs And Outputs, Program Format, Introduction To Logic, Equivalent Ladder Diagram Of - AND Gate, OR Gate, NOT Gate, XOR Gate, NAND Gate, NOR Gate, Equivalent Ladder Diagram To Demonstrate De Morgan Theorem, Ladder Design.

Module -2 PLC Timers And Counters
Timer And Its Classification, Characteristics Of PLC Timer, Functions In Timer, Resetting – Retentive And Non-Retentive, Classification Of PLC Timer, On Delay, And Off Delay Timers, Timer-On Delay, Timer Off Delay, Retentive And Non-Retentive Timers, Format of a Timer Instruction, PLC Counter, Operation Of PLC Counter, Counter Parameters, Counter Instructions. Overview, Count Up (CTU), Count Down (CTD).

Advanced Instructions
Comparison Instructions, Addressing Data Files, Format Of Logical Address, Addressing Format for Micrologic System, Different Addressing Types. Data Movement Instructions.

Module -3 Logical Instructions
Mathematical Instructions and its Features, Special Mathematical Instructions, Scale with Parameters or SCP Instruction. Data Handling Instructions and its Features, Program Flow Control Instructions, Proportional Integral Derivative (PID) Instruction.

PLC I/O Modules And Power Supply

Module -4 Industrial Communication

Module -5 Industrial Networking

Industrial Automation
Introduction, Utility Of Automation, General Structure of a Automated Process, Examples of Simple Automated Systems, Selection Of PLC.

Question paper pattern:
- The question paper will have ten questions.
- Each full question consists of 20 marks.
- There will be 2 full questions (with a maximum of four sub questions) from each module.
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The students will have to answer 5 full questions, selecting one full question from each module.

Text Book:

Reference Books:
Table: ANTENNA THEORY AND DESIGN

<table>
<thead>
<tr>
<th>Module</th>
<th>Topics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Module 4</td>
<td>Aperture antennas: Techniques for evaluating gain, Reflector antennas- Parabolic reflector antenna principles, Axisymmetric parabolic reflector antenna, Offset parabolic reflectors, Dual reflector antennas, Gain calculations for reflector antennas, Feed antennas for reflectors, Field representations, Matching the feed to the reflector, General feed model, Feed antennas used in practice.</td>
</tr>
<tr>
<td>Module 5</td>
<td>CEM for antennas: The method of moments: Introduction of the methods moments, Pocklington's integral equation, Integral equation and Kirchhoff’s networking equations, Source modeling weighted residual formulations and computational consideration, Calculation of antenna and scatter characteristics.</td>
</tr>
</tbody>
</table>

Question paper pattern:
- The question paper will have ten questions.
- Each full question consists of 20 marks.
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.


Reference Books:
### Module -1
**Digital Models For The Speech Signal:** Process of speech production, Acoustic theory of speech production, Lossless tube models, and Digital models for speech signals. (Text 1)

**Time Domain Models for Speech Processing:** Time dependent processing of speech, Short time energy and average magnitude, Short time average zero crossing rate, Speech vs silence discrimination using energy & zero crossings, Pitch period estimation, Short time autocorrelation function, Short time average magnitude difference function, Pitch period estimation using autocorrelation function, Median smoothing. (Text 1)

### Module -2
**Digital Representations of the Speech Waveform:** Sampling speech signals, Instantaneous quantization, Adaptive quantization, Differential quantization, Delta modulation, Differential PCM, Comparison of systems, direct digital code conversion. (Text 1)

**Short Time Fourier Analysis:** Linear Filtering interpretation, Filter bank summation method, Overlap addition method, Design of digital filter banks, Implementation using FFT, Spectrographic displays, Pitch detection, Analysis by synthesis, Analysis synthesis systems. (Text 1)

### Module -3
**Homomorphic Speech Processing:** Homomorphic systems for convolution, Complex cepstrum, Pitch detection, Formant estimation, Homomorphic vocoder. Linear Predictive Coding of Speech: Basic principles of linear predictive analysis, Solution of LPC equations, Prediction error signal, Frequency domain interpretation, Relation between the various speech parameters, Synthesis of speech from linear predictive parameters, Applications. (Text 1)

### Module -4

### Module -5
**Automatic Speech Recognition:** Introduction, Speech recognition vs. Speaker recognition, Signal processing and analysis methods, Pattern comparison techniques, Hidden Markov Models, Artificial Neural Networks. (Text 2)

**Audio Processing:** Auditory perception and psychoacoustics - Masking, frequency and loudness perception, spatial perception, Digital Audio, Audio Coding - High quality, low-bit-rate audio coding standards, MPEG, AC-3, Multichannel audio - Stereo, 3D binaural and Multichannel surround sound. (Text 3)

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### Text Books:

### Reference Book:
**Visvesvaraya Technological University, Belagavi.**

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<table>
<thead>
<tr>
<th>03</th>
<th>16ESP12</th>
<th>Group-4</th>
<th>Statistical Signal Processing</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Exam Hours:</strong> 03</td>
<td><strong>Exam Marks:</strong> 100</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Module -1**  
**Random Processes:** Random variables, random processes, white noise, filtering random processes, spectral factorization, ARMA, AR and MA processes (Text 1).

**Module -2**  
**Signal Modeling:** Least squares method, Padé approximation, Prony's method, finite data records, stochastic models, Levinson-Durbin recursion; Schur recursion; Levinson recursion (Text 1).

**Module -3**  
**Spectrum Estimation:** Nonparametric methods, minimum-variance spectrum estimation, maximum entropy method, parametric methods, frequency estimation, principal components spectrum estimation (Text 1).

**Module -4**  
**Optimal and Adaptive Filtering:** FIR and IIR Wiener filters, Discrete Kalman filter, FIR Adaptive filters: Steepest descent, LMS, LMS-based algorithms, adaptive recursive filters, RLS algorithm (Text 1).

**Module -5**  
**Array Processing:** Array fundamentals, beam-forming, optimum array processing, performance considerations, adaptive beam-forming, linearly constrained minimum-variance beam-formers, side-lobe cancellers, space-time adaptive processing (Text 2).

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**Text Books:**

**Reference Books:**
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<table>
<thead>
<tr>
<th>Module-1</th>
<th>Classical Detection and Estimation Theory: Introduction, simple binary hypothesis tests, M Hypotheses, estimation theory, composite hypotheses, general Gaussian problem, performance bounds and approximations. (Text 1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Module-3</td>
<td>Detection of Signals – Estimation of Signal Parameters: Introduction, detection and estimation in white Gaussian noise, detection and estimation in nonwhite Gaussian noise, signals with unwanted parameters, multiple channels and multiple parameter estimation. (Text 1)</td>
</tr>
<tr>
<td>Module-4</td>
<td>Estimation of Continuous Waveforms: Introduction, derivation of estimator equations, lower bound on the mean-square estimation error, multidimensional waveform estimation, nonrandom waveform estimation. (Text 1)</td>
</tr>
<tr>
<td>Module-5</td>
<td>Linear Estimation: Properties of optimum processors, realizable linear filters, Kalman-Bucy filters, fundamental role of optimum linear filters. (Text 1)</td>
</tr>
</tbody>
</table>

**Question paper pattern:**
- The question paper will have ten questions.
- Each full question consists of 20 marks.
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**Text Books:**

**Reference Books:**
<table>
<thead>
<tr>
<th>Module</th>
<th>Course Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Module -1</td>
<td><strong>Basic MOS Device Physics</strong>: General considerations, MOS I/V Characteristics, second order effects, MOS device models.  <strong>Single stage Amplifier</strong>: Basic Concepts, Common Source stage. (Text 1)</td>
</tr>
<tr>
<td>Module -2</td>
<td><strong>Single stage Amplifier</strong>: Source follower, common-gate stage, Cascode Stage, choice of device models.  <strong>Differential Amplifiers</strong>: Single ended and differential operation, Basic differential pair, Common mode response, Differential pair with MOS loads, Gilbert cell. (Text 1)</td>
</tr>
<tr>
<td>Module -3</td>
<td><strong>Passive and Active Current Mirrors</strong>: Basic current mirrors, Cascode Current mirrors, Active Current mirrors.  <strong>Operational Amplifiers (part-1)</strong>: General Considerations, One Stage OP-Amp, Two Stage OP-Amp, Gain boosting. (Text 1)</td>
</tr>
<tr>
<td>Module -4</td>
<td><strong>Operational Amplifiers (part-2)</strong>: Common Mode Feedback, Slew rate, Power Supply Rejection.  <strong>Phase Locked Loops</strong>: Simple PLL, Charge pump PLLs, Non-ideal effects in PLLs, Delay-Locked Loops, Applications. (Text 1)</td>
</tr>
<tr>
<td>Module -5</td>
<td><strong>Data Converter Architectures</strong>: DAC &amp; ADC Specifications, Current Steering DAC, Charge Scaling DAC, Cyclic DAC, Pipeline DAC, Flash ADC, Pipeline ADC, Integrating ADC, Successive Approximation ADC. (Text 2)</td>
</tr>
</tbody>
</table>

**Question paper pattern:**
- The question paper will have ten questions.
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- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
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**Text Books:**

**Reference Book:**
# Advances in VLSI Design

## Module 1: Implementation Strategies For Digital ICS

## Module 2: Coping With Interconnect

## Module 3: Timing Issues In Digital Circuits

## Module 4: Designing Memory and Array Structures
- Introduction, Memory Classification, Memory Architectures and Building Blocks, The Memory Core, Read-Only Memories, Nonvolatile Read-Write Memories, Read-Write Memories (RAM), Contents-Addressable or Associative Memory (CAM), Memory Peripheral Circuitry, The Address Decoders, Sense Amplifiers, Voltage References, Drivers/Buffers, Timing and Control.

## Module 5: Designing Memory and Array Structures

### Question paper pattern:
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### Text Book:

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<th>16EIE22</th>
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<th>Design of Power Converters</th>
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<tbody>
<tr>
<td>Exam Hours:03</td>
<td>Exam Marks:100</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Module -1**
Introduction to Control characteristics of power semiconductor devices: SCR, BJT, MOSFET, GTO, MCT, SITH, IGBT. Comparison of controllable switches. AC to Controlled DC Converter: Thyristor circuits and their control, Gate Triggering, Single phase converters, Three phase converters. (Text 1)

**Module -2**
DC to DC converters: Introduction, control of DC-DC converters, Buck, Boost, Buck-Boost, Cuk converter. Inverters: Introduction, principle of operation, single phase inverters, three phase inverters-120 and 180 modes of operation. (Text 1)

**Module -3**
Switching DC power supplies: linear power supply, overview of switching power supply, DC - DC converters with electrical isolation, flyback converter, forward converter, push-pull converter, Half and Full bridge converter, current mode control, power supply protection. (Text 1)

**Module -4**
Magnetics for switched mode converters: Power Handling capacity of a transformer, Area product, window utilization factor. Transformer designs – forward converter, half and Full Bridge converter, Push-pull converter, Flyback converter. Design of Inductors, problems. (Text 2)

**Module -5**
PWM controlling Techniques: single PWM, Multiple, sinusoidal, modified, phase displacement control. Power electronic applications: UPS, control of motor drives, criteria for selecting drive components, High frequency fluorescent lighting. Industrial applications: Induction heating, Electric welding. (Text 1)

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<tr>
<th>01</th>
<th>16ECS153</th>
<th>Group-5</th>
<th>OPTICAL COMMUNICATION AND NETWORKING</th>
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<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>**Exam Hours:**03</td>
</tr>
<tr>
<td><strong>Module -1</strong></td>
<td>Introduction to optical networking: Propagation of signals in optical fiber, Different losses, Nonlinear effects, Solutions, Optical sources, Detectors.</td>
<td></td>
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</tr>
<tr>
<td><strong>Optical Components (Part-1):</strong></td>
<td>Couplers, Isolators, Circulators and Multiplexers.</td>
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</tr>
<tr>
<td><strong>Module -2</strong></td>
<td>Optical Components (Part-2): Filters, Gratings, Interferometers, Amplifiers.</td>
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</tr>
<tr>
<td><strong>Modulation - Demodulation:</strong></td>
<td>Formats, Ideal receivers, Practical detection receivers, Optical preamplifiers, Noise considerations, Bit error rates, Coherent detection.</td>
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</tr>
<tr>
<td><strong>Module -3</strong></td>
<td>Transmission System Engineering: System model, Power penalty, Transmitter, Receiver, Different optical amplifiers.</td>
<td></td>
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</tr>
<tr>
<td><strong>Client Layers:</strong></td>
<td>Client layers of optical layer, SONET/SDH, Multiplexing, layers, Frame structure, ATM functions, Adaptation layers, Quality of Service (QoS) and flow control, ESCON, HIPPI.</td>
<td></td>
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<tr>
<td><strong>Module -4</strong></td>
<td>WDM network elements: Optical line terminal, Optical line amplifiers, Optical Add/ Drop Multiplexors, Optical cross connectors.</td>
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<tr>
<td><strong>WDM Network Design:</strong></td>
<td>WDM network design, Cost tradeoffs, LTD and RWA problems, Routing and wavelength assignment, Wavelength conversion.</td>
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</tr>
<tr>
<td><strong>Module -5</strong></td>
<td>Control and Management (Part-1): Network management functions, management framework, Information model, management protocols, Layers within optical layer.</td>
<td></td>
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<tr>
<td><strong>Control and Management (Part-2):</strong></td>
<td>Performance and fault management, Impact of transparency, BER measurement, Optical trace, Alarm management, Configuration management.</td>
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<tr>
<td><strong>Question paper pattern:</strong></td>
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<table>
<thead>
<tr>
<th>Exam Hours:03</th>
<th>Exam Marks:100</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Module -1 Introduction to networks</strong>: Computer network, Telephone networks, Networking principles (Text 1), Protocol layering (Text 2), Multiplexing- TDM, FDM, SM, WDM (Text 1). <strong>Multiple Access</strong>: Introduction, Choices and constraints, base technologies, centralized and distributed access schemes (Text 2).</td>
<td></td>
</tr>
<tr>
<td><strong>Module -2. Local Area Networks</strong>: Ethernet - Physical layer, MAC, LLC, LAN interconnection, Token ring- Physical layer, MAC, LLC, FDDI (Text 1). Switching- introduction, circuit switching, packet switching, multicasting (Text 2). <strong>Scheduling</strong>: Introduction, requirements, choices, performance bounds, best- effort techniques. Naming and addressing (Text 2).</td>
<td></td>
</tr>
<tr>
<td>**Module -3 SONET, SDH (Text 2), ATM Networks- features, signaling and routing, header and adaptation layers (Text 1), virtual circuits, SSCOP, Internet- addressing, routing, end point control (Text 2). <strong>Internet protocols</strong>: IP, TCP, UDP, ICMP, HTTP (Text 2).</td>
<td></td>
</tr>
<tr>
<td><strong>Module -4 Traffic Management</strong>: Introduction, framework for traffic management, traffic models, traffic classes, traffic scheduling (Text 2). <strong>Control of Networks</strong>: Objectives and methods of control, routing optimization in circuit and datagram networks, Markov chains, Queuing models in circuit and datagram networks (Text 1). <strong>Module -5 Congestion and flow control</strong>: Window congestion control, rate congestion control, control in ATM Networks (Text 1), flow control model, open loop flow control, closed loop flow control (Text 2).</td>
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</tr>
</tbody>
</table>

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<table>
<thead>
<tr>
<th>03</th>
<th>16ECS254</th>
<th>Group-5</th>
<th>CRYPTOGRAPHY AND NETWORK SECURITY</th>
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<tbody>
<tr>
<td><strong>Exam Hours:</strong> 03</td>
<td><strong>Exam Marks:</strong> 100</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Module -1 Foundations:</strong> Terminology, Steganography, substitution ciphers and transpositions ciphers, Simple XOR, One-Time Pads, Computer Algorithms (Text 2: Chapter 1: Section 1.1 to 1.6)</td>
<td></td>
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</tr>
<tr>
<td><strong>SYMMETRIC CIPHERS:</strong> Traditional Block Cipher structure, Data encryption standard (DES), The AES Cipher. (Text 1: Chapter 2: Section2.1, 2.2, Chapter 4)</td>
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</tr>
<tr>
<td><strong>Module -2</strong> Introduction to modular arithmetic, Prime Numbers, Fermat’s and Euler’s theorem, primality testing, Chinese Remainder theorem, discrete logarithm. (Text 1: Chapter 7: Section 1, 2, 3, 4, 5) Principles of Public-Key Cryptosystems, The RSA algorithm, Diffie - Hellman Key Exchange, Elliptic Curve Arithmetic, Elliptic Curve Cryptography (Text 1: Chapter 8, Chapter 9: Section 9.1, 9.3, 9.4)</td>
<td></td>
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<td></td>
</tr>
<tr>
<td><strong>Module -3</strong> Pseudo-Random-Sequence Generators and Stream Ciphers: Linear Congruential Generators, Linear Feedback Shift Registers, Design and analysis of stream ciphers, Stream ciphers using LFSRs, A5, Hughes XPD/KPD, Nanoteq, Rambutan, Additive generators, Gifford, Algorithm M, PKZIP (Text 2: Chapter 16)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Module -4</strong> One-Way Hash Functions: Background, Snefru, N-Hash, MD4, MD5, Secure Hash Algorithm [SHA],One way hash functions using symmetric block algorithms, Using public key algorithms, Choosing a one-way hash functions, Message Authentication Codes. Digital Signature Algorithm, Discrete Logarithm Signature Scheme (Text 2: Chapter 18: Section 18.1 to 18.5, 18.7, 18.11 to 18.14 and Chapter 20: Section 20.1, 20.4)</td>
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<tr>
<th>Module</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Introduction-Genesis and significance of bio electric potentials, ECG, EOG, EMG and their monitoring and measurement, Spectral analysis.</td>
</tr>
<tr>
<td>2</td>
<td>Filtering- digital and analog filtering, correlation and estimation techniques, AR / ARMA models, Adaptive Filters.</td>
</tr>
<tr>
<td>3</td>
<td>ECG-Pre-processing. Measurements of amplitude and time intervals, Classification, QRS detection, ST segment analysis, Base line wander removal, waveform recognition, morphological studies and rhythm analysis, automated diagnosis based on decision theory ECT compression, Evoked potential estimation.</td>
</tr>
<tr>
<td>4</td>
<td>EEG: Evoked responses, Epilepsy detection, Spike detection, Hjorth parameters, averaging techniques, removal of Artifacts by averaging and adaptive algorithms, pattern recognition of alpha, beta, theta and delta waves in EEG waves, sleep stages.</td>
</tr>
<tr>
<td>5</td>
<td>EMG-Wave pattern studies, bio feedback, Zero crossings, Integrated EMG. Time frequency methods and Wavelets in Biomedical Signal Processing.</td>
</tr>
</tbody>
</table>

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**Text Book:**

**Reference Books:**
1) R E Chellis and Rl Kitney, “Biomedical Signal Processing”, in IV parts, Medical and Biological Engg. and current computing, 1990-91.
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**PhD Coursework Courses – 2018 (Electronics and Communication Engineering)**

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<table>
<thead>
<tr>
<th>Module</th>
<th>Exam Hours:03</th>
<th>Exam Marks:100</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1</strong></td>
<td><strong>Introduction:</strong> Applications of pattern recognition, statistical decision theory, image processing and analysis. Probability: Introduction, probability of events, random variables, Joint distributions and densities, moments of random variables, estimation of parameters from samples, minimum risk estimators <strong>Statistical Decision Making:</strong> Introduction, Baye’s Theorem, multiple features, conditionally independent features, decision boundaries, unequal costs of error, estimation of error rates, the leaving-one—out technique. Characteristic curves, estimating the composition of populations.</td>
<td></td>
</tr>
<tr>
<td><strong>2</strong></td>
<td><strong>Nonparametric Decision Making:</strong> Introduction, histograms, Kernel and window estimators, nearest neighbor classification techniques, adaptive Decision boundaries, adaptive discriminate Functions, minimum squared error discriminate functions, choosing a decision making technique.</td>
<td></td>
</tr>
<tr>
<td><strong>3</strong></td>
<td><strong>Unsupervised Classification:</strong> Clustering, Hierarchical Clustering, Graph Based Method, Sum of Squared Error Technique, Iterative Optimization clustering.</td>
<td></td>
</tr>
<tr>
<td><strong>4</strong></td>
<td><strong>Neural Network Classifier:</strong> Single and Multilayer Perceptron, Back Propagation Learning, Hopfield Network, Fuzzy Neural Network.</td>
<td></td>
</tr>
<tr>
<td><strong>5</strong></td>
<td><strong>Time Varying Pattern Recognition:</strong> First Order Hidden Markov Model Evaluation, Decoding, Learning.</td>
<td></td>
</tr>
</tbody>
</table>

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<table>
<thead>
<tr>
<th>Exam Hours:03</th>
<th>Exam Marks:100</th>
<th>Real Time Operating System</th>
</tr>
</thead>
</table>

**Module -1 Real-Time Systems and Resources:** Brief history of Real Time Systems, A brief history of Embedded Systems. System Resources, Resource Analysis, Real-Time Service Utility, Scheduler concepts, Real-Time OS, State transition diagram and tables, Thread Safe Reentrant Functions. (Text 1: Selected sections from Chap. 1, 2)

**Module -2 Processing with Real Time Scheduling:** Scheduler Concepts, Preemptive Fixed Priority Scheduling Policies with timing diagrams and problems and issues, Feasibility, Rate Monotonic least upper bound, Necessary and Sufficient feasibility, Deadline ~Monotonic Policy, Dynamic priority policies, Alternative to RM policy. (Text 1: Chap. 2,3,7)

**Module -3 Memory and I/O:** Worst case execution time, Intermediate I/O, Shared Memory, ECC Memory, Flash file systems. Multi-resource Services, Blocking, Deadlock and live lock, Critical sections to protect shared resources, Missed deadline, QoS, Reliability and Availability, Similarities and differences, Reliable software, Available software. (Text 1: Selected topics from Chap. 4,5,6,7,11)

**Module -4 Firmware Components:** The 3 firmware components, RTOS system software mechanisms, Software application components. Debugging Components, Exceptions, assert, Checking return codes, Singlestep debugging, kernel scheduler traces, Test access ports, Trace Ports, External test equipment. (Text 1: Selected topics from Chap. 8,9)

**Module -5 Process and Threads:** Process and thread creations, Simple Programs, Programs related to semaphores, message queue, shared buffer applications involving inter task/thread communication using multiple threads. (Text 2: Chap. 11)

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<thead>
<tr>
<th>07</th>
<th>16ECS424</th>
<th>Group-5</th>
<th>Real Time Systems</th>
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<tbody>
<tr>
<td><strong>Exam Hours:</strong></td>
<td>03</td>
<td><strong>Exam Marks:</strong></td>
<td>100</td>
</tr>
</tbody>
</table>


**Module -2 Processing:** Preemptive Fixed-Priority Policy, Feasibility, Rate Monotonic least upper bound, Necessary and Sufficient feasibility, Deadline – Monotonic Policy, Dynamic priority policies.

**I/O Resources:** Worst-case Execution time, Intermediate I/O, Execution efficiency, I/O Architecture.

**Memory:** Physical hierarchy, Capacity and allocation, Shared Memory, ECC Memory, Flash file systems.

**Module -3 Multi-resource Services:** Blocking, Deadlock and livestock, Critical sections to protect shared resources, priority inversion.

**Soft Real-Time Services:** Missed Deadlines, QoS, Alternatives to rate monotonic policy, Mixed hard and soft real-time services.

**Module -4 Embedded System Components:** Firmware components, RTOS system software mechanisms, Software application components.

**Debugging Components:** Exceptions assert, Checking return codes, Single-step debugging, kernel scheduler traces, Test access ports, Trace ports, Power-On self test and diagnostics.

**Module -5 Performance Tuning:** Basic concepts of drill-down tuning, hardware – supported profiling and tracing, Building performance monitoring into software, Path length.

**High availability and Reliability Design:** Reliability and Availability, Similarities and differences, Reliability, Reliable software, Available software, Design tradeoffs, Hierarchical applications for Fail-safe design.

**Question paper pattern:**
- The question paper will have ten questions.
- Each full question consists of 20 marks.
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.

The students will have to answer 5 full questions, selecting one full question from each module.

**Text Book:**

**Reference Books:**
Visvesvaraya Technological University, Belagavi.
PhD Coursework Courses – 2018 (Electronics and Communication Engineering)
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<table>
<thead>
<tr>
<th>Exam Hours:03</th>
<th>Exam Marks:100</th>
<th>ASIC DESIGN</th>
</tr>
</thead>
</table>

**Module -1 Introduction to ASICs:** Full custom, Semi-custom and Programmable ASICs, ASIC Design flow, ASIC cell libraries.

**CMOS Logic:** Datapath Logic Cells: Data Path Elements, Adders: Carry skip, Carry bypass, Carry save, Carry select, Conditional sum, Multiplier (Booth encoding), Data path Operators, I/O cells.

**Module -2ASIC Library Design:** Logical effort: Predicting Delay, Logical area and logical efficiency, Logical paths, Multi stage cells, Optimum delay and number of stages.

**Programmable ASIC Logic Cells:** MUX as Boolean function generators, Actel ACT: ACT 1, ACT 2 and ACT 3 Logic Modules, Xilinx LCA: XC3000 CLB, Altera FLEX and MAX.

**Module -3Programmable ASIC I/O Cells:** Xilinx and Altera I/O Block.

**Low-level design entry:** Schematic entry: Hierarchical design, Netlist screener.

**ASIC Construction:** Physical Design, CAD Tools.

**Partitioning:** Goals and objectives, Constructive Partitioning, Iterative Partitioning improvement, KL, FM and Look Ahead algorithms.

**Module -4Floor planning and placement:** Goals and objectives, Floor planning tools, Channel definition, I/O and Power planning and Clock planning. Placement: Goals and Objectives, Min-cut Placement algorithm, Iterative Placement Improvement, Physical Design Flow.

**Module -5 Routing:** Global Routing: Goals and objectives, Global Routing Methods, Back-annotation. Detailed Routing: Goals and objectives, Measurement of Channel Density, Left-Edge and Area-Routing Algorithms. Special Routing, Circuit extraction and DRC.

**Question paper pattern:**
- The question paper will have ten questions.
- Each full question consists of 20 marks.
- There will be 2 full questions (with a maximum of four sub questions) from each module.
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The students will have to answer 5 full questions, selecting one full question from each module.

**Text Book:**

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Visvesvaraya Technological University, Belagavi.
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<table>
<thead>
<tr>
<th>09</th>
<th>16EVE13</th>
<th>Group-5</th>
<th>ADVANCED EMBEDDED SYSTEM</th>
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<tbody>
<tr>
<td><strong>Exam Hours:</strong> 03</td>
<td><strong>Exam Marks:</strong> 100</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Module -1 Embedded System:** Embedded vs General computing system, classification, application and purpose of ES. Core of an Embedded System, Memory, Sensors, Actuators, LED, Optocoupler, Communication Interface, Reset circuits, RTC, WDT. Characteristics and Quality Attributes of Embedded Systems (Selected Topics from Ch 1, 2, 3 of Text 1).

**Module -2 Hardware Software Co-Design:** Hardware Software Co-Design, embedded firmware design approaches, computational models, embedded firmware development languages, Integration and testing of Embedded Hardware and firmware, Components in embedded system development environment (IDE), Files generated during compilation, simulators, emulators and debugging (Selected Topics From Ch-7, 9, 12, 13 of Text 1).

**Module -3 ARM-32 bit Microcontroller:** Thumb-2 technology and applications of ARM, Architecture of ARM Cortex M3, Various Units in the architecture, General Purpose Registers, Special Registers, exceptions, interrupts, stack operation, reset sequence (Ch 1, 2, 3 of Text 2).

**Module -4 Instruction Sets:** Assembly basics, Instruction list and description, useful instructions, Memory Systems, Memory maps, Cortex M3 implementation overview, pipeline and bus interface (Ch-4, 5, 6 of Text 2).

**Module -5 Exceptions, Nested Vector interrupt controller design, Systick Timer, Cortex-M3 Programming using assembly and C language, CMSIS (Ch-7, 8, 10 of Text 2).**

**Question paper pattern:**
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The students will have to answer 5 full questions, selecting one full question from each module.

**Text Books:**

**Reference Book:**
Module -1 Introduction: Need for low power VLSI chips, charging and discharging capacitance, short circuit current in CMOS leakage current, static current, basic principles of low power design, low power figure of merits.

Simulation power analysis: SPICE circuit simulation, discrete transistor modeling and analysis, gate level logic simulation, architecture level analysis, data correlation analysis in DSP systems, Monte Carlo simulation.

Module -2 Probabilistic power analysis: Random logic signals, probability & frequency, probabilistic power analysis techniques, signal entropy.

Circuit: Transistor and gate sizing, equivalent pin ordering, network restructuring and reorganization, special latches and flip flops, low power digital cell library, adjustable device threshold voltage.

Module -3 Logic: Gate reorganization, signal gating, logic encoding, state machine encoding, pre-computation logic (Text 1).

Low power Clock Distribution: Power dissipation in clock distribution, single driver Vs distributed buffers, Zero skew Vs tolerable skew, chip & package co design of clock network (Text 2).

Module -4 Low power Architecture & Systems: Power & performance management, switching activity reduction, parallel architecture with voltage reduction, flow graph transformation (Text 1).

Low power arithmetic components: Introduction, circuit design style, adders, multipliers, division (Text 2).

Module -5 Low power memory design: Introduction, sources and reductions of power dissipation in memory subsystem, sources of power dissipation in DRAM and SRAM (Text 2).


Advanced Techniques: Adiabatic computation, pass transistor, Asynchronous circuits (Text 1).

Question paper pattern:

- The question paper will have ten questions.
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Reference Books:
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PhD Coursework Courses – 2018 (Electronics and Communication Engineering)
As per 2017 Regulation

<table>
<thead>
<tr>
<th>Exam Hours:03</th>
<th>Exam Marks:100</th>
</tr>
</thead>
</table>
| **Module -1 AN INTRODUCTION TO ELECTRICAL DRIVES & ITS APPLICATIONS:** Electrical Drives, Advantages of Electrical Drives, Parts of Electrical Drives, Choice of Electrical Drive, Status of dc and ac Drives, Fundamental Torque Equations, Speed Torque Conventions and Multiquadrant Operation.

**Applications:** Rolling mill drives, cement mill drives, paper mill drives and textile mill drives.

**Module -2 SELECTION OF MOTOR POWER RATING:** Thermal model of motor for heating and cooling, Classes of motor duty, determination of motor rating.

**D C MOTOR DRIVES 1:** Starting braking, transient analysis, single phase fully controlled rectifier, control of dc separately excited motor. Single-phase half controlled rectifier: control of dc separately excited motor.

**Module -3 DC MOTOR DRIVES 2:** Three phase fully controlled rectifier: control of dc separately excited motor, three phases half controlled rectifier: control of dc separately excited motor, multiquadrant operation of dc separately excited motor fed form fully controlled rectifier. Rectifier control of dc series motor, chopper controlled dc drives, chopper control of separately excited dc motor. Chopper control of series motor.

**Module -4 INDUCTION MOTOR DRIVES:** Operation with unbalanced source voltage and single phasing, operation with unbalanced rotor impedances, analysis of induction motor fed from non-sinusoidal voltage supply, starting braking, transient analysis. Stator voltage control variable voltage frequency control from voltage sources, voltage source inverter control, closed loop control, current source inverter control, current regulated voltage source inverter control.

**Module -5 SYNCHRONOUS MOTOR DRIVES:** Operation form faced frequency supply, synchronous motor variable speed drives, and variable frequency control of multiple synchronous motors. Self-controlled synchronous motor drive employing load commutated thruster inverter.

**Question paper pattern:**
- The question paper will have ten questions.
- Each full question consists of 20 marks.
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.

The students will have to answer 5 full questions, selecting one full question from each module.

**Text Book:**

**Reference Books:**
Visvesvaraya Technological University, Belagavi.
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<table>
<thead>
<tr>
<th>01</th>
<th>16ECS252</th>
<th>Group-6</th>
<th>MULTIMEDIA OVER COMMUNICATION LINKS</th>
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<tr>
<td><strong>Exam Hours:</strong> 03</td>
<td><strong>Exam Marks:</strong> 100</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Module -1 Multimedia Communications:</strong> Introduction, Multimedia information representation, multimedia networks, multimedia applications, Application and networking terminology. (Chap. 1 of Text 1)</td>
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<tr>
<td><strong>Information Representation:</strong> Introduction, Text, Images. (Chap. 2- Sections 2.2 and 2.3 of Text 1)</td>
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<tr>
<td><strong>Module -2. Information Representation:</strong> Audio and Video. (Chap. 2 - Sections 2.4 and 2.5 of Text 1)</td>
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<tr>
<td><strong>Distributed multimedia systems:</strong> Introduction, main Features of a DMS, Resource management of DMS, Networking, Multimedia operating systems. (Chap. 4 - Sections 4.1 to 4.5 of Text 2)</td>
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<tr>
<td><strong>Module -3 Multimedia Processing in Communication:</strong> Introduction, Perceptual coding of digital Audio signals, Transform Audio Coders, Audio Sub band Coders. (Chap. 3 - Sections 3.1, 3.2, 3.6, 3.7 of Text 2)</td>
<td></td>
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</tr>
<tr>
<td><strong>Module -4 Multimedia Communication Standards:</strong> Introduction, MPEG approach to multimedia standardization, MPEG-1, MPEG-2, Overview of MPEG-4. (Chap. 5 - Sections 5.1 to 5.4 and 5.5.1 of Text 2)</td>
<td></td>
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</tr>
<tr>
<td><strong>Module -5 Multimedia Communication Across Networks:</strong> Packet audio/video in the network environment, Video transport across generic networks, Multimedia Transport across ATM Networks. (Chap. 6 - Sections 6.1, 6.2, 6.3 of Text 2)</td>
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</tbody>
</table>

**Question paper pattern:**
- The question paper will have ten questions.
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**Text Books:**

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<tr>
<th>02</th>
<th>16ECS24</th>
<th>Group-6</th>
<th>RF AND MICROWAVE CIRCUIT DESIGN</th>
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<tbody>
<tr>
<td>Exam Hours:03</td>
<td>Exam Marks:100</td>
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</tr>
</tbody>
</table>


Module -3Basic consideration in active networks: Stability Considerations, Gain Considerations and Noise Considerations.

Module -4 RF/Microwave Amplifiers: Small Signal Design: Introduction, Types of amplifier, Design of different types of amplifiers
RF/Microwave Frequency Conversion: Mixers: Introduction, Mixer Types, Conversion Losses for SSB Mixers, SSB versus DSB mixers, One diode mixers, Two diode Mixers.

Module -5 RF/Microwave Control Circuit Design: Introduction, PN Junction Devices, Phase shifters, Digital phase shifters, Semiconductor phase shifters, PIN diode attenuators.
RF and Microwave IC design: MICs, MIC materials, Types of MICs, Hybrid verses Monolithic ICs, Chip mathematics

Question paper pattern:
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- The students will have to answer 5 full questions, selecting one full question from each module.

Text Book:

Reference Book:
Visvesvaraya Technological University, Belagavi.

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<table>
<thead>
<tr>
<th>03</th>
<th>16ESP41</th>
<th>Group-6</th>
<th>Adaptive Signal Processing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exam Hours:03</td>
<td>Exam Marks:100</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Module -1** Adaptive systems : Definitions and characteristics - applications - properties-examples - adaptive linear combiner input signal and weight vectors - performance function-gradient and minimum mean square error - introduction to filtering-smoothing and prediction - linear optimum filtering-orthogonality – WienerHopf equation- Performance Surface. (Text 1)


**Module -3** LMS algorithm convergence of weight vector: LMS/Newton algorithm - properties - sequential regression algorithm – adaptive recursive filters - random-search algorithms - lattice structure - adaptive filters with orthogonal signals. (Text 1)

**Module -4** Applications-adaptive modeling: Multipath communication channel, geophysical exploration, FIR digital filter synthesis. (Text 2)

**Module -5** System identification-adaptive modeling: Inverse adaptive modeling, equalization, and deconvolution adaptive equalization of telephone channels-adapting poles and zeros for IIR digital filter synthesis. (Text 2)

Question paper pattern:
- The question paper will have ten questions.
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- The students will have to answer 5 full questions, selecting one full question from each module.

**Text Books:**

**Reference Books:**
## Visvesvaraya Technological University, Belagavi.

**PhD Coursework Courses – 2018  (Electronics and Communication Engineering)**

*As per 2017 Regulation*

<table>
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<tr>
<th>04</th>
<th>16ESP152</th>
<th>Group-6</th>
<th>Multirate Systems and Filter Banks</th>
</tr>
</thead>
<tbody>
<tr>
<td>**Exam Hours:**03</td>
<td>**Exam Marks:**100</td>
<td><strong>Module -1</strong> Fundamentals of Multi-rate Systems: Basic multi-rate operations, interconnection of building blocks, poly-phase representation, multistage implementation, applications of multi-rate systems, special filters and filter banks (Text 1).</td>
<td></td>
</tr>
<tr>
<td><strong>Module -2</strong> Maximally decimated filter banks: Errors created in the QMF bank, alias-free QMF system, power symmetric QMF banks, M-channel filter banks, poly-phase representation, perfect reconstruction systems, alias-free filter banks, tree structured filter banks, trans-multiplexers (Text 1).</td>
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<tr>
<td><strong>Module -3</strong> Para-unitary Perfect Reconstruction Filter Banks: Lossless transfer matrices, filter bank properties induced by para-unitariness, two channel Para-unitary lattices, M-channel FIR Para-unitary QMF banks, transform coding (Text 1).</td>
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<tr>
<td><strong>Module -4</strong> Linear Phase Perfect Reconstruction QMF Banks: Necessary conditions, lattice structures for linear phase FIR PR QMF banks, formal synthesis of linear phase FIR PR QMF lattice (Text 1). Cosine Modulated Filter Banks: Pseudo-QMF bank and its design, efficient poly-phase structures, properties of cosine matrices, cosine modulated perfect reconstruction systems (Text 1).</td>
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<tr>
<td><strong>Module -5</strong> Wavelet Transform: Short-time Fourier transform, Wavelet transform, discrete-time Ortho-normal wavelets, continuous time Ortho-normal wavelets (Text 2).</td>
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</tbody>
</table>

**Question paper pattern:**
- The question paper will have ten questions.
- Each full question consists of 20 marks.
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
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**Text Books:**

**Reference Book:**
Visvesvaraya Technological University, Belagavi.
PhD Coursework Courses – 2018 (Electronics and Communication Engineering)
As per 2017 Regulation

<table>
<thead>
<tr>
<th>Module</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>Spectrum Estimation: Introduction, Correlogram method, Periodogram Computation of FFT, properties of Periodogram method such as bias analysis, window design considerations. Signals with Rational spectra. ARMA state – space Equation, sub space Parameter Estimation (Text 1).</td>
</tr>
<tr>
<td>4</td>
<td>Filter Bank Method: Filter bank Interpretation of the period gram, Refined Filter bank Method, Capon Method, Filter Bank Reinterpretation of the periodogram (Text 1).</td>
</tr>
<tr>
<td>5</td>
<td>Optimum Linear Filter : Optimum Signal Estimation, Linear MSE Estimation, Solution of the normal equations optimum FIR and IIR filters. Inverse filtering and deconvolution (Text 2).</td>
</tr>
</tbody>
</table>

Question paper pattern:
- The question paper will have ten questions.
- Each full question consists of 20 marks.
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

Text Books:
<table>
<thead>
<tr>
<th>Module</th>
<th>Topic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Module -1</td>
<td><strong>Introduction to the course</strong>: Digital filters, Discrete time convolution and frequency responses, FIR filters - Using circular buffers to implement FIR filters in C and using DSP hardware, Interfacing C and assembly functions, Linear assembly code and the assembly optimizer. IIR filters - realization and implementation, FFT and power spectrum estimation: DFT/FFT window function, DFT and IDFT, FFT, Using FFT to implement power spectrum.</td>
</tr>
</tbody>
</table>
| Module -5 | Question paper pattern:  

- The question paper will have ten questions.
- Each full question consists of 20 marks.
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module. |

**Text Book:**  

**Reference Books:**  
**Visvesvaraya Technological University, Belagavi.**  
**PhD Coursework Courses – 2018 (Electronics and Communication Engineering)**  
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<tr>
<th>07</th>
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<th>SIMULATION, MODELLING AND ANALYSIS</th>
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<tr>
<td><strong>Exam Hours:</strong> 03</td>
<td><strong>Exam Marks:</strong> 100</td>
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</tr>
<tr>
<td><strong>Module -1 Basic Simulation Modeling:</strong></td>
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<tr>
<td>Nature of simulation, Systems, Models and Simulation, Discrete-Event Simulation, Simulation of Single Server Queuing System, Simulation of inventory system, Parallel and distributed simulation and the high level architecture, Steps in sound simulation study, and Other types of simulation, Advantages and disadvantages. (1.1, 1.2, 1.3, 1.4, 1.4.1, 1.4.2, 1.4.3, 1.5, 1.5.1, 1.5.2, 1.6, 1.7, 1.8, 1.9 of Text)</td>
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<tr>
<td><strong>Module -2 Review of Basic Probability and Statistics</strong></td>
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<tr>
<td>Random Variables and their properties, Simulation Output Data and Stochastic Processes, Estimation of Means, Variances and Correlations, Confidence Intervals and Hypothesis tests for the Mean</td>
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<tr>
<td><strong>Building valid, credible and appropriately detailed simulation models:</strong> Introduction and definitions, Guidelines for determining the level of models detail, Management’s Role in the Simulation Process, Techniques for increasing model validity and credibility, Statistical procedure for comparing the real world observations and simulation output data. (4.2, 4.3, 4.4, 4.5, 5.1, 5.2, 5.4, 5.5, 5.6, 5.6.1, 5.6.2 of Text)</td>
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<tr>
<td><strong>Module -3 Selecting Input Probability Distributions:</strong></td>
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<tr>
<td>Useful probability distributions, activity I, II and III. Shifted and truncated distributions; Specifying multivariate distribution, correlations, and stochastic processes; Selecting the distribution in the absence of data, Models of arrival process. (6.2, 6.4, 6.5, 6.6, 6.8, 6.10, 6.11, 6.12 of Text).</td>
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<tr>
<td><strong>Module -4 Random Number Generators:</strong></td>
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<tr>
<td>Linear congruential Generators, Other kinds, Testing number generators, Generating the Random Variates:</td>
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<tr>
<td>General approaches, Generating continuous random variates, Generating discrete random variates, Generating random vectors, and correlated random variants, Generating arrival processes (7.2, 7.3, 7.4, 8.2, 8.3, 8.4, 8.5, 8.6 of Text).</td>
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<tr>
<td><strong>Module -5 Output data analysis for a single system:</strong></td>
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<tr>
<td>Transient and steady state behavior of a stochastic process; Types of simulations with regard to analysis; Statistical analysis for terminating simulation; Statistical analysis for steady state parameters; Statistical analysis for steady state cycle parameters; Multiple measures of performance, Time plots of important variables. (9.2, 9.3, 9.4, 9.4.1, 9.4.3, 9.5, 9.5.1, 9.5.2, 9.5.3, 9.6, 9.7, 9.8 of Text)</td>
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</table>

**Question paper pattern:**
- The question paper will have ten questions.
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- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

**Text Book:**

**Reference Books:**
2. Jerry Banks, "Discrete event system Simulation", Pearson, 2009
<table>
<thead>
<tr>
<th>08</th>
<th>16EVE22</th>
<th>Group-6</th>
<th>VLSI Testing</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Exam Hours:</strong> 03</td>
<td><strong>Exam Marks:</strong> 100</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Module -1 Faults in digital circuits:** Failures and Faults, Modeling of faults, Temporary Faults. (Text 1)

**Logic Simulation:** Applications, Problems in simulation based design verification, types of simulation, The unknown logic values, compiled simulation, event-driven simulation, Delay models, Element evaluation, Hazard detection, Gate-level event-driven Simulation. (Text 2)

**Module -2 Test generation for Combinational Logic circuits:** Fault Diagnosis of digital circuits, Test generation techniques for combinational circuits, Detection of multiple faults in combinational logic circuits. (Text 1)

**Testable Combinational logic circuit design:** The Read-Muller expansion technique, Three level OR-AND-OR design, Automatic synthesis of testable logic. (Text 1)

**Module -3 Testable Combinational logic circuit design:** Testable design of multilevel combinational circuits, Synthesis of random pattern testable combinational circuits, Path delay fault testable combinational logic design, Testable PLA design. (Text 1)

**Test generation for Sequential circuits:** Testing of sequential circuits as Iterative combinational circuits, state table verification, Test generation based on Circuit Structure, Functional Fault models, test Generation based on Functional Fault models. (Text 1)

**Module -4 Design of testable sequential circuits:** Controllability and observability, Ad-Hoc design rules for improving testability, design of diagnosable sequential circuits, the scan-path technique for testable sequential circuit design, Level Sensitive Scan Design(LSSD), Random Access Scan Technique, Partial scan, testable sequential circuit design using Nonscan Techniques, Cross check, Boundary Scan. (Text 1)

**Module -5 Built-In Self Test:** Test pattern generation for BIST, Output response analysis, Circular BIST, BIST Architectures. (Text 1)

**Testable Memory Design:** RAM Fault Models, Test algorithms for RAMs, Detection of pattern-sensitive faults, BIST techniques for RAM chips, Test generation and BIST for embedded RAMs. (Text 1)

**Question paper pattern:**
- The question paper will have ten questions.
- Each full question consists of 20 marks.
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

**Text Books:**

**Reference Books:**
Visvesvaraya Technological University, Belagavi.

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<table>
<thead>
<tr>
<th>Exam Hours:03</th>
<th>Exam Marks:100</th>
<th>SoC Design</th>
</tr>
</thead>
</table>

**Module -1 ARM Organization and Implementation:** 3-stage pipeline ARM organization, 5-stage pipeline ARM organization, ARM instruction execution, ARM implementation, The ARM coprocessor interface.

**The ARM Instruction Set:** Introduction, Exceptions, Conditional execution, Branch and Branch with Link (B, BL), Branch with Link and eXchange (BX, BLX), Software Interrupt (SWI), Data processing instructions, Multiply instructions, Count leading zeros (CLZ - architecture v5T only), Single word and unsigned byte data transfer instruction, Half-word and signed byte data transfer instructions, Multiple register transfer instructions, Swap memory and register instructions (SWP), Status register to general register transfer instructions, General register to status register transfer instructions, Coprocessor instructions, Coprocessor data operations, Coprocessor data transfers, Coprocessor register transfers, Breakpoint instruction (BRK - architecture v5T only), Unused instruction space, Memory faults, ARM architecture variants.

**Module -2 Architectural Support for High-Level Languages:** Abstraction in software design, Data types, Floating-point data types, The ARM floating-point architecture, Expressions, Conditional statements, Loops, Functions and procedures, Use of memory, Run-time environment.

**Architectural Support for System Development:** The ARM memory interface, The Advanced Microcontroller Bus Architecture (AMBA), The ARM reference peripheral specification, Hardware system prototyping tools, The ARMulator, The JTAG boundary scan test architecture, The ARM debug architecture, Embedded Trace, Signal processing support.

**Module -3 ARM Processor Cores:** ARM7TDMI, ARM8, ARM9TDMI, ARM10TDMI, Discussion, Example and exercises.

**Memory Hierarchy:** Memory size and speed, On-chip memory, Caches, Cache design - an example, Memory management, Examples and exercises.

**Module -4 Architectural Support for Operating Systems:** An introduction to operating systems, The ARM system control coprocessor, CP15 protection unit registers, ARM protection unit, CP15 MMU registers, ARM MMU architecture, Synchronization, Context switching, Input/Output, Example and exercises.


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- Each full question consists of 20 marks.
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- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

**Text Book:**

**References Books:**
Visvesvaraya Technological University, Belagavi.
PhD Coursework Courses – 2018 (Electronics and Communication Engineering)  
As per 2017 Regulation

<table>
<thead>
<tr>
<th>Module</th>
<th>Course Content</th>
</tr>
</thead>
</table>
| Module -2 | Non-Clocked logic styles: Introduction, static CMOS structures, DC VS logic, Non-clocked pass-gate families.  
| Module -3 | Circuit Design margin and design variability: Introduction, process induced variation, design induced variations, and application induced variations', Noise.  
Latching Strategies: Introduction, basic latch design, latching single ended logic, latching differential logic, race-free latched for pre-charge logic. |
| Module -4 | Interface Techniques: Introduction, signaling standard, chip-chip communication networks, ESD protection, Driver design techniques, receiver design techniques. |
| Module -5 | Clocking styles: Introduction, clock jitter and skew, clock generation and clock distribution. |

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Text Book:
<table>
<thead>
<tr>
<th>Module</th>
<th>Course Title</th>
<th>Exam Hours</th>
<th>Exam Marks</th>
<th>Text Book</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-6EVE421</td>
<td>CMOS RF Circuit Design</td>
<td>03</td>
<td>100</td>
<td>B. Razavi, RF Microelectronics, PHI, 2nd edition</td>
</tr>
</tbody>
</table>

**Module -1 Introduction to RF Design and Wireless Technology:**
Basic concepts in RF design(I): General considerations, Effects of Nonlinearity, Noise, Sensitivity and dynamic range.

**Module -2 Basic concepts in RF design (II):** Passive impedance transformation, scattering parameters, analysis of nonlinear dynamic systems.

**Module -3 Communication Concepts:** General concepts, analog modulation, digital modulation, spectral re-growth, Mobile RF communications, Multiple access techniques, Wireless standards.

**Module -4 Transceiver Architecture(I):** General considerations, Receiver architecture.

**Module -5 Transceiver Architecture(II):** Transmitter architectures

**Low Noise Amplifiers:** LNA topologies: common-source stage with inductive load, common-source stage with resistive feedback.

**Mixers:** General considerations, passive down conversion mixers.

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<table>
<thead>
<tr>
<th>12</th>
<th>16EVE252</th>
<th>Group-6</th>
<th>VLSI Design for Signal Processing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exam Hours:03</td>
<td>Exam Marks:100</td>
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</tbody>
</table>

**Module -1 Introduction to DSP Systems:** Typical DSP Algorithms, DSP Application Demands and Scaled CMOS Technologies, Representations of DSP Algorithms.

**Iteration Bounds:** Data flow graph Representations, loop bound and Iteration bound.

**Module -2 Iteration Bounds:** Algorithms for Computing Iteration Bound, Iteration Bound of multi rate data flow graphs.

**Pipelining and Parallel Processing:** pipelining of FIR Digital Filters, parallel processing, Pipelining and parallel processing for low power.

**Module -3 Retiming:** Definition and Properties, Solving Systems of Inequalities, Retiming Techniques,

**Unfolding:** An Algorithm for Unfolding, Properties of Unfolding, Critical path, Unfolding and Retiming, Application of Unfolding.

**Systolic Architecture Design:** systolic array design Methodology, FIR systolic array.

**Module -4 Systolic Architecture Design:** Selection of Scheduling Vector, Matrix-Matrix Multiplication and 2D systolic Array Design, Systolic Design for space representation containing Delays.

**Fast convolution:** Cook-Toom Algorithm, Winograd Algorithm, Iterated convolution, cyclic convolution Design of fast convolution Algorithm by Inspection.

**Module -5 Pipelined and Parallel Recursive and Adaptive Filter:** Pipeline Interleaving in Digital Filter, first order IIR digital Filter. Higher order IIR digital Filter, parallel processing for IIR filter, Combined pipelining and parallel processing for IIR Filter, Low power IIR Filter Design Using Pipelining and parallel processing, pipelined adaptive digital filter.

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<table>
<thead>
<tr>
<th>13</th>
<th>16EIE423</th>
<th>Group-6</th>
<th>Medical Imaging</th>
</tr>
</thead>
<tbody>
<tr>
<td>**Exam Hours:**03</td>
<td>**Exam Marks:**100</td>
<td></td>
<td></td>
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<tr>
<td><strong>Module -1 Generation and Detection of X-Rays:</strong> X-Ray generation and X-Ray generators, Filters, Beam Restrictors and Grids, Screens, X-Ray Detectors.</td>
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<tr>
<td><strong>X-Ray Diagnostic Methods:</strong> Conventional X-Ray Radiography, Fluoroscopy, Angiography, Mammography, Xeroradiography, Image Subtraction.</td>
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<tr>
<td><strong>X-Ray Image Characteristics:</strong> Spatial Resolution, Image Noise, Image contrast.</td>
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<tr>
<td><strong>Biological Effects of Ionizing Radiation:</strong> Determination of biological effects, Short term and Long term effects.</td>
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<tr>
<td><strong>Module -2 X-Ray Tomography:</strong> Conventional Tomography, Computed Tomography - Projection function, Algorithms for Image Reconstruction, CT number, Image Artifacts.</td>
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<tr>
<td><strong>Digital Radiography:</strong> Digital Subtraction Angiography (DSA), Dual Energy Subtraction, K-Edge subtraction, 3-D Reconstruction.</td>
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<tr>
<td><strong>Recent Developments:</strong> Dynamic Spatial Reconstructor (DSR), Imatron or Fastrac Electron Beam CT.</td>
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<tr>
<td><strong>Module -3 Generation and Detection of Ultrasound:</strong> Piezoelectric effect, Ultrasonic Transducers, Transducer Beam Characteristics, Axial and Lateral resolution, Focussing and Arrays.</td>
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<tr>
<td><strong>Ultrasonic Diagnostic Methods:</strong> Pulse Echo systems - A mode, B mode, M mode and C mode, Transmission Methods, Doppler methods, Duplex Imaging</td>
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<tr>
<td><strong>Biological Effects of Ultrasound:</strong> Acoustic phenomena at high intensity levels, Ultrasound Bioeffects.</td>
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<tr>
<td><strong>Module -4 Generation and Detection of Nuclear Emission:</strong> Nuclear Sources, Radionuclide Generators, Nuclear Radiation Detectors, Collimators.</td>
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<tr>
<td><strong>Diagnostic methods using Radiation Detector Probes:</strong> Thyroid Function test, Renal function test, Blood volume measurement.</td>
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<tr>
<td><strong>New Radio Nuclide Imaging methods:</strong> Longitudinal Section Tomography, SPECT and PET</td>
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<tr>
<td><strong>Characteristics of Radionuclide Images:</strong> Spatial Resolution, Image contrast, Image Noise.</td>
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<tr>
<td><strong>Module -5 Generation and Detection of NMR signal:</strong> The NMR Coil/Probe, The transmitter and the Receiver, Data acquisition.</td>
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<tr>
<td><strong>Magnetic Resonance Imaging methods:</strong> Spin Echo Imaging, Gradient Echo Imaging, Blood flow Imaging.</td>
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<tr>
<td><strong>Characteristics of MRI images:</strong> Spatial Resolution, Image Contrast. <strong>Imaging Safety.</strong></td>
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</tbody>
</table>

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<table>
<thead>
<tr>
<th>14</th>
<th>16EIE421</th>
<th>Group-6</th>
<th>Advanced Power Electronic Converters and Applications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exam Hours: 03</td>
<td>Exam Marks: 100</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Module -1 Introduction to power electronics:</strong></td>
<td>Introduction to Power Processing, Several Applications of Power Electronics, Elements of Power Electronics.</td>
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<tr>
<td><strong>Principles of Steady State Converter Analysis:</strong></td>
<td>Inductor Volt-Second Balance, Capacitor Charge Balance, and the Small-Ripple Approximation, Boost Converter Example, Cuk Converter Example Estimating the Output voltage ripple and inductor current ripple in converters Containing Two-Pole Low-Pass Filter. (Text 1)</td>
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</tr>
<tr>
<td><strong>Module -2 Converter Dynamics and Control:</strong></td>
<td>AC Equivalent Circuit Modeling, The Basic AC Modeling Approach, State-Space Averaging, Circuit Averaging and Averaged Switch Modeling, The Canonical Circuit Model, Modeling the Pulse-Width Modulator, Analysis of Converter Transfer Functions, Graphical Construction of Impedances and Transfer Functions (Text 1)</td>
<td></td>
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</tr>
<tr>
<td><strong>Module -3 Controller Design:</strong></td>
<td>Introduction, Effect of Negative Feedback on the Network Transfer Functions, Construction of the Important Quantities 1/(1 + T) and T/(1 + T) and the Closed-Loop Transfer Functions, Stability, The Phase Margin Test, The Relationship Between Phase Margin and Closed-Loop Damping Factor, Transient Response vs. Damping Factor, Regulator Design, Measurement of Loop Gains. (Text 1)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Module -4 Modern Rectifiers and Power System Harmonics:</strong></td>
<td>Power and Harmonics in Nonsinusoidal Systems, Pulse-Width Modulated Rectifiers.</td>
<td></td>
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</tr>
<tr>
<td><strong>Resonant Converters:</strong></td>
<td>Sinusoidal Analysis of Resonant Converters with examples (Text 1)</td>
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<tr>
<td><strong>Module -5 Power supply applications:</strong></td>
<td>Switching DC Power Supplies, Motor drive applications: Introduction to Motor Drives, DC-Motor Drives, Residential and Industrial Applications, Electric Utility Applications (Text 2)</td>
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<table>
<thead>
<tr>
<th>Module</th>
<th>Content</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td><strong>Module -1 Linear Algebra-I</strong>&lt;br&gt;Introduction to vector spaces and sub-spaces, definitions, illustrative examples and simple problems. Linearly independent and dependent vectors-definition and problems. Basis vectors, dimension of a vector space. Linear transformations-definition, properties and problems. Rank-Nullity theorem(without proof). Matrix form of linear transformations-Illustrative examples. <em>(Text 1 &amp; Ref. 1)</em></td>
</tr>
<tr>
<td>2</td>
<td><strong>Module -2 Linear Algebra-II</strong>&lt;br&gt;Computation of Eigen values and Eigen vectors of real symmetric matrices-Given’s method. Orthogonal vectors and orthogonal bases. Gram-Schmidt orthogonalization process. QR decomposition, singular value decomposition, least square approximations. <em>(Text 1 &amp; Ref. 1)</em></td>
</tr>
<tr>
<td>3</td>
<td><strong>Module -3 Calculus of Variations</strong>&lt;br&gt;Concept of functional-Euler’s equation. Functional dependent on first and higher order derivatives, functional on several dependent variables. Isoperimetric problems-variation problems with moving boundaries. <em>(Text 2 &amp; Ref. 2)</em></td>
</tr>
<tr>
<td>4</td>
<td><strong>Module -4 Probability Theory</strong>&lt;br&gt;Review of basic probability theory. Definitions of random variables and probability distributions, probability mass and density functions, expectation, moments, central moments, characteristic functions, probability generating and moment generating functions-illustrations. Binomial, Poisson, Exponential, Gaussian and Rayleigh distributions-examples. <em>(Text 3 &amp; Ref. 3)</em></td>
</tr>
<tr>
<td>5</td>
<td><strong>Module -5 Joint probability distributions</strong>&lt;br&gt;Definition and properties of CDF, PDF, PMF, conditional distributions. Expectation, covariance and correlation. Independent random variables. Statement of central limit theorem-Illustrative examples. Random process- Classification, stationary and ergodic random process. Auto correlation function-properties, Gaussian random process. <em>(Text 3 &amp; Ref. 3)</em></td>
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