## SCHEME OF COURSE WORK

COURSE DETAILS:

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| Course Title | **Introduction to Digital Signal Processing** |
| Course Code | **13EE1116** |
| Program | B.Tech |
| Branch | Electrical & Electronics Engineering |
| Semester | VI |
| Prerequisites | Introduction to Signals & Systems |
| Course to which it is prerequisite | All Advanced Courses In Electrical Engineering |

COURSE OUTCOMES:

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| CO1 | Classify various types of discrete time signals and systems |
| CO2 | Compute Discrete Fourier Series (DFS), Discrete time Fourier Transform (DTFT), Discrete Fourier Transform (DFT) and Fast Fourier Transform (FFT). |
| CO3 | Design Infinite Impulse Response Filters |
| CO4 | Design Finite Impulse Response Filters. |
| CO5 | Describe the basics of DSP Processors. |

The student of Electrical and Electronics Engineering at the end of the program will be able to:

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| 1 | Apply the knowledge of basic sciences and electrical and electronics engineering fundamentals to solve the problems of power systems and drives. |
| 2 | Analyze power systems that efficiently generate, transmit and distribute electrical power in the context of present Information and Communications Technology |
| 3 | Design and develop electrical machines and associated controls with due considerations to societal and environmental issues |
| 4 | Design and conduct experiments, analyze and interpret experimental data for performance analysis |
| 5 | Apply appropriate simulation tools for modeling and evaluation of electrical systems |
| 6 | Apply the electrical engineering knowledge to assess the health and safety issues and their consequences |
| 7 | Demonstrate electrical engineering principles for creating solutions for sustainable development |
| 8 | Develop a techno ethical personality that help to serve the people in general and Electrical and Electronics Engineering in particular |
| 9 | Develop leadership skills and work effectively in a team to achieve project objectives |
| 10 | Communicate effectively in both verbal and written form |
| 11 | Understand the principles of management and finance to manage project in multi disciplinary environments |
| 12 | Pursue life-long learning as a means of enhancing the knowledge and skills |

COURSE OUTCOME/PROGRAM OUTCOMES:

| CO'S | PO-1 | PO-2 | PO-3 | PO-4 | PO-5 | PO-6 | PO-7 | PO-8 | PO-9 | PO-10 | PO-11 | PO-12 |
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| CO-1 | M | M | M | M | M | M | | | | | | M |
| CO-2 | M | M | M | M | M | M | | | | | | M |
| CO-3 | M | M | M | M | M | M | | | | | | M |
| CO-4 | M | M | M | M | M | M | | | | | | M |
| C0-5 | M | M | M | M | M | M | | | | | | M |

Assessment Methods: Assignments/Quiz/Mid Exam/Seminar/Viva-Voce/End Exam

TEACHING LEARNING AND EVALUATION

| Weeks | Topic/content | CO | Sample questions | Teaching-learning stategy | Assessment method & schedule |
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| 1 | **Unit-I INTRODUCTION:**: Discrete – time signals and Systems, Representations, Elementary Signals, Basic Operations on signals, Classification of Signals, Classification of Discrete time systems. | CO-1 | 1). Test whether the following systems are linear or nonlinear, causal or non-Causal, and time variant or time-invariant and specify the reason.<br>a). $y(n) = x^2(n) + \frac{\square 1}{x^2(n-1)}$<br>b). $y(n) = \log_{10} x(n)$<br>,<br>2). Determine whether the following signals are energy signals, power signals or neither i) x(n) = 2ej3n, ii) x(n) = (-0.5)n u(n) (2 marks)<br>b) Determine whether the signals are periodic or not. If periodic find the fundamental period. i) x(n) = sin (n/9 – π) and ii) x(n) = cos (2πn/7). | Lecture/discussion/problem solving | Assignment-1 & quiz- 1 |
| 2 | Impulse Response and Convolution Sum, Convolution of Infinite sequences, Circular shift and Circular Symmetry. | CO-1 | 1). Compute the following<br>a)Linear convolution between x(n) = {1, 2,-1} and h(n) = {2, 1,-2,1}<br>b.) Find the convolution of x(n) = cos(nπ)u(n), h(n) = (1/2)n u(n) | Lecture/discussion/problem solving | Assignment-1 & quiz- 1 |
| 3 | Periodic or Circular Convolution. Methods of obtaining Circular Convolution Examples.<br>**unit-II DISCRETE FOURIER** | CO-1 CO-2 | 1). Circular convolution between x(n) = x(n) = { 1, 1, 1, 1, -1, -1, -1, -1} and h(n) = {0, 1, 2, 3, 4, 3, 2, 1}<br>.<br>2). State and prove any three properties of DFS | Lecture/discussion/problem solving | Assignment-1 & quiz- 1 |

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| | **SERIES, DISCRETE TIME FOURIER TRANSFORM, DISCRETE FOURIER TRANSFORM & FAST FOURIER TRANSFORM** Introduction, Discrete Fourier series, Properties of DFS. | | | | |
| 4 | Discrete time Fourier transform, Relation between Z-Transform and DTFT, Inverse DTFT, Properties of DTFT, Frequency Response of DT Systems, Transfer Functions.. | CO-2 | 1). a). The impulse response of a LTI system is h(n)={1,2,1,-2}. Find the response of the system for input x(n) = {1,3,2,1} using DTFT<br>b). Find the DTFT of sin(nπ/2) u(n)<br>2. find the IDFT of X(k) = {4,2,0,4} | Lecture/discussion /problem solving | Assignment-1 & quiz- 1 |
| 5 | Discrete Fourier Transform, IDFT, Properties of DFT, Relation between Z-Transform and DFT, Linear Convolution and Circular Convolution using DFT.<br>. | CO-2 | 1). State and prove the Time Reversal, circular frequency shift , circular time shift properties of DFT<br>2. Find the 8-point DFT of x(n) = {1,1}. Use the property of conjugate symmetry<br>3. computation of linear and circular convolution using DFT | Lecture/discussion /problem solving | Assignment-1 & quiz- 1 |
| 6 | Fast Fourier Transform, Decimation in time radix – 2 FFT, Decimation in frequency radix1 – FFT, Butterfly Diagram, 8 – Point | C0-2<br>CO-3 | 1). compute the 8-point DFT by using Radix-2 DIT-FFT algorithm x(n) = {0.5,0.5,0.5,0.5,0,0,0,0}<br>(2). compute the 8-point DFT by using Radix-2 DIF-FFT algorithm x(n) = {1,1,1,1}<br>3. Given an analog filter transfer function H(s) = 1/(s+1), use | Lecture/discussion /problem solving | Assignment-1 & quiz- 1 |

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| | DFT Calculation.<br>**UNIT-III INFINITE IMPULSE RESPONSE FILTERS**: Introduction, Analog Filter Fundamentals, Transformation methods, Design of IIR Filters, Low Pass Filter specifications, | | impulse invariant method and obtain the digital filter transfer function.<br><br>4. Obtain the relation between analog frequency and digital frequency in bilinear transformation? what is wraping effect | | |
| 7 | Design by approximation of derivatives, Impulse invariant transformation, Bilinear transformation, LP Butterworth digital filter | CO-3 | 1. Obtain a Butterworth digital IIR low pass filter transfer function impulse invariance by taking T=0.5s, to satisfy the following specifications.<br>$0.707 \le \lvert H(\mu) \rvert \le 1; \quad 0 \le \mu \le 0.45$®<br>$\lvert H(\mu) \rvert \le 0.2; \quad 0.65$® $\le \mu \le$ ® | Lecture/discussion /problem solving | Assignment-1 & quiz- 1 |
| 8 | Bilinear transformation, LP Butterworth digital filter | CO-3 | 1. Obtain a Butterworth digital IIR low pass filter transfer function using bilinear transformation by taking T=0.5s, to satisfy the following specifications.<br>$0.707 \le \lvert H(\mu) \rvert \le 1; \quad 0 \le \mu \le 0.45$®<br>$\lvert H(\mu) \rvert \le 0.2; \quad 0.65$® $\le \mu \le$ ® | Lecture/discussion /problem solving | Assignment-1 & quiz- 1 |
| 9 | MID TEST-1 | | | | |
| 10 | Chebyshev filter, Inverse Chyebshev filter, Elliptic filters, Frequency transformation. | Co-3 | 1). Design a Chebyshev low pass filter to meet the following specifications<br>i). 1 dB ripple in pass band<br>$0 \le \mu \le 0.2$® ii) 25dB | Lecture/discussion n/problem solving | Assignment-2 & quiz- 2 |

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| | | | attenuation in stop band $0.3\pi \le \omega \le \pi$ using Impulse invariance method.<br><br>2. write a short note on Elliptic Filters and Inverse Chyebshev filter | | |
| 11 | **Unit-IV**<br>**FINITE IMPULSE RESPONSE FILTERS**: Introduction, Characteristics of FIR filters with linear phase | CO-4 | 1). briefly explain the characteristics of FIR filters with linear phase | Lecture/discussion/ problem solving | Assignment-2 & quiz- 2 |
| 12 | Frequency response of linear phase FIR filters, | CO-4 | 1). Design a high pass FIR filter using hamming window with cutoff frequency of 1.2 rad/sec and Number of samples of the window is 9 | Lecture/discussion /problem solving | Assignment-2 & quiz- 2 |
| 13 | Design of FIR filters using windows (Rectangular, Triangular, Raised Cosine, Hanning, Hamming, Blackman and Kaiser). | CO-4 | 1). Design a filter with<br>$H_d(e^{j\omega}) = e^{-j3\omega}$ *for* $\frac{-\pi}{4} \le \omega \le \frac{\pi}{4}$<br>$= 0$ *for* $\frac{\pi}{4} \le \lvert\omega\rvert \le \pi$<br>Using a Hamming window N = 7<br><br>2. Design a filter with<br>$H_d(e^{j\omega}) = e^{-j3\omega}$ *for* $\frac{-\pi}{4} \le \omega \le \frac{\pi}{4}$<br>$= 0$ *for* $\frac{\pi}{4} \le \lvert\omega\rvert \le \pi$<br>Using a Rectangular window N = 7 | Lecture/discussion /problem solving | Assignment-2 & quiz- 2 |
| 14 | **Unit-V**<br>**INTRODUCTION TO DSP PROCESSORS**<br>Introduction, MAC operation | CO-5 | advantages and disadvantages of DSP processors and MAC operation | Lecture/discussion | Assignment-2 & quiz- 2 |

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| 15 | Multiple Access Memory, VLIW architecture Special addressing modes | C0-5 | 1), Briefly explain the special addressing modes in P-DSPs<br>2. Explain the VLIW architecture with its block diagram. | Lecture/discussion | Assignment-2 & quiz-2 |
| 16 | Pipelining<br>On-chip peripherals | CO-5 | 1). Explain Pipelining concept<br>2). Explain on-chip peripherals | Lecture/discussion | Assignment-2 & quiz-2 |
| 17 | Architecture of TMS320C5x. | CO-5 | 1). Explain TMS320C5X architecture with its block diagram | | |
| 18 | MID Exam-2 | | | | |
| 19, 20 | End Exam | All co's | | | External exam |