GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering
Subject Code: 3170918
Semester – VII
Subject Name: Digital Signal Processors

Type of course: Professional Elective Course IV

Prerequisite:

Rationale:

Many Electrical and Power Electronics Applications require complex control schemes and signal processing. Hence, for such applications, embedded processor having very good control capacity and signal processing capacity both are required. So, special processors combining both these capacities are used in such applications. They are Digital Signal Controllers (DSC). They combine the best features of microcontrollers (MCU) and powerful digital signal processing (DSP) capabilities in one single chip Considering this, it becomes necessary for any electrical and power electronics engineer involved in product development to understand the concepts of Digital Signal Processing (Theoretical). Also they should understand Digital Signal Controllers from practical implementation point of view. This subject includes both of these.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE (E)	PA (M)	ESE (V)	PA (I)	
3	0	0	3	70	30	0	0	100

Content:

Sr no.	Topics	Teaching Hrs.
1	Introduction: Signals – Classification – Continuous& Discrete Time Signals – Basic Operations on Signals & Sequences – Elementary Signals - Discrete Time Systems &Properties of System, Impulse response of DT-LTI system, Linear Convolution. Sampling of Continuous Time Signals – Sampling Theorem – Aliasing & it's Effects, Signal reconstruction.	4
2	Discrete Time systems and implementation Concepts of Z transformation, properties of Z transformation etc., Block diagram / signal flow graph representation of DT System, Structures for realization of FIR & IIR Systems – Direct, Cascade, Parallel & Linear phase.	4
3	Fourier series and Fourier Transform of DT signals: Concepts of Discrete Time Fourier series, Discrete Time Fourier Transforms –Properties, Analysis of DT-LTI systems using DTFT etc. DFT- Relationship of DFT & other transforms, Properties, Frequency spectrum using DFT, Analysis of LTI system using DFT, DFT as Linear Transformation. FFT– DIT Radix-2 FFT, DIFRadix-2 FFT, Computation of Inverse DFT using FFT.	8
4	Representation of Numbers in digital system (Floating point, Fixed-point representation), Types of arithmetic in digital system, Quantization effect & Errors therein, Concept of Limit Cycle Oscillations & Scaling	4
5	Architecture of DSP and C2000 family Features of Processors– Types of architecture, Concepts of DMA, MAC, Pipelining etc., introduction to DSP architecture. Peripherals available in DSP IC chips, requirements of on chip hardware for power electronics applications. Introduction to C2000 family of	8

	microcontrollers: Comparison of C2000 real time microcontrollers like PICOLO, DELFINO, 28M3x etc., with reference to on chip peripherals, processing capacity, applications etc.	
6	Code Composer Studio: Introduction to CCS as IDE for TI processors, Basics of CCS, Multiprocessing with CCS, Testing Program, debugging Breakpoints, points, using file I/O, Memory map, Watch window, Integrated editor, project environment	4
7	Software Development and Programming: Overview, description, object module, program loading and running, Assembler, Assembler directives, Macros, Linker, using C language Writing program for some simple objectives like initializing peripheral, timer interrupt and ISR for timer interrupt, PWM generation etc. for C2000 microcontrollers.	5
8	TI 320F28X Digital Signal Controllers: TMS320F28335 Introduction, Functional Overview, Memory map, brief description of available peripherals, register maps, device emulation registers, interrupts, system control, On chip Peripherals of TMS320F28335(or any other C2000 Family processor): Timers, PWM generation, ADC, Serial Communication, GPIO, Flash Memory	8

Suggested Specification Table with Marks (Theory): (for BE only)

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
20	**30**	**15**	**15**	**10**	**0**

Legends: R: Remembrance; U: Understanding; A: Application - N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)

1. **Remembering:** Retrieving - recognizing - and recalling relevant knowledge from long-term memory.
2. **Understanding:** Constructing meaning from oral - written - and graphic messages through interpreting - exemplifying - classifying - summarizing - inferring - comparing - and explaining.
3. **Applying:** Carrying out or using a procedure for executing or implementing.
4. **Analysing:** Breaking material into constituent parts - determining how the parts relate to one another and to an overall structure or purpose through differentiating - organizing - and attributing.
5. **Evaluating:** Making judgments based on criteria and standards through checking and critiquing.
6. **Creating:** Putting elements together to form a coherent or functional whole; reorganizing elements into a new pattern or structure through generating - planning - or producing.

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Reference Books/Material:

1. DSP-Based Electromechanical Motion Control (Power Electronics and Applications Series), Hamid A. Toliyat (Author), Steven G. Campbell, CRC press
2. TI technical documents: Code Composer Studio User's Guide, Document no. SPRU328B (Data Manual 28335), SPRS439M (TI 28335 Data sheet), SPRUI07 (Technical Reference Manual), SPRU513V (Discrete TMS320C28x Assembly Language Tools User's Guide), SPRU514V (TMS320C28x Optimizing C/C++ Compiler v20.12.0.STS) , SPRAC71A (C28x Embedded Application Binary Interface), SPRU566N (C2000 Real-Time Control Peripherals)
3. The DSP Handbook Algorithms, Applications and design techniques, Andrew Bateman, Iain Paterson-Stephens, Pearson Education
4. C the complete reference, Herbert Scheldt
5. Digital Signal Processing: Principles, Algorithms, and Applications, Dimitris Manolakis and John G Proakis, Pearson

Course Outcomes:

Sr. No.	CO statement After studying this subject, student will be able to	Topics Mapped	Marks % weightage
CO-1	understand concepts of Digital Signal Processing implementation requirements of Power Electronics systems	1, 2, 3	30
CO-2	select appropriate Digital Signal Processor / Controller for a given application	5, 8	30
CO-3	apply concepts of Digital Signal Processing to practical application	4, 8	10
CO-4	apply the software development tools in a real time embedded application.	6, 7	30

List of Open-Source Software/learning website:

Learning website:

1. http://nptel.iitm.ac.in/courses.php
2. http://ocw.mit.edu/
3. www.ti.com
4. http://www.electrical-engineering-portal.com
5. www.nxp.com
6. www.microship.com
7. www.st.com
8. https://www.ti.com/microcontrollers-mcus-processors/microcontrollers/c2000-real-time-control-mcus/overview.html#portfolio
9. http://software-dl.ti.com/C2000/docs/software_guide/intro.html
10. https://software-dl.ti.com/C2000/docs/optimization_guide/index.html
11. https://www.ti.com/tool/CCSTUDIO#tech-docs
12. https://www.ti.com/tool/CCSTUDIO
13. https://software-dl.ti.com/ccs/esd/documents/users_guide/index.html