DEPARTMENT OF INSTRUMENTATION AND CONTROL ENGG.

NATIONAL INSTITUTE OF TECHNOLOGY, TIRUCHIRAPPALLI

COURSE PLAN – PART I			
Name of the programme and specialization	**B.Tech in Instrumentation and Control Engineering**		
Course Title	**Digital Signal Processing**		
Course Code	**ICPE30 -(VII semester)**	**No. of Credits**	**03**
Course Code of Pre-requisite subject(s)			
Session	**July 2023**	**Section (if, applicable)**	**-**
Name of Faculty	Dr. Karthick P.A	**Department**	**ICE DEPARTMENT**
Email	pakarthick@nitt.edu	**Telephone No.**	
Name of Course Coordinator(s)			
E-mail	**pakarthick@nitt.edu**	**Telephone No.**	
Course Type	☐ **Core course**	☑ **Elective course**	

Syllabus (approved in BoS)

Signal Processing Fundamentals: Discrete-time and digital signals, A/D, D/A conversion and Nyquist rate, Frequency aliasing due to sampling, Need for anti-aliasing filters. Discrete Time Fourier transform and frequency spectra, Spectral computation, Computational complexity of the DFT and the FFT, Algorithmic development and computational advantages of the FFT, Inverse FFT, Implementation of the FFT, Correlation of discrete-time signals. Discrete-time systems, Difference equations and the Z-transform, Analysis of discrete-time LTIL systems, Stability and Jury's test. FIR Filters: Ideal digital filters, Realizability and filter specifications, Classification of linear phase FIR filters, Design using direct truncation, window methods and frequency sampling, Least squares optimal FIR filters, Minimax optimal FIR filters, Design of digital differentiators and Hilbert transformers, comparison of design methods. IIR Filters: Design of analog prototype filters, Analog frequency transformations, Impulse invariance method and digital frequency transformations, Bilinear transformation, Analog prototype to digital transformations, Difficulties in direct IIR filter design, Comparisons with FIR filters. Filter Realization: Structures for FIR filters, Structures for IIR filters, State-space analysis and filter structures, Fixed point and floating-point representation of numbers, Errors resulting from rounding and truncating, Quantization effects of filter coefficients, Round-off effects of digital filters. DSP Processors: Computer architectures for signal processing – Harvard architecture and pipelining, General purpose digital signal processors, Selection of DSPs, Implementation of DSP algorithms on a general purpose DSP, Special purpose hardware – hardware digital filters and hardware FFT processors, Evaluation boards for real-time DSP.

COURSE OBJECTIVES

The objectives of this course is:

1. To provide higher level of understanding of discrete-time and digital signal in time and frequency domains.
2. To provide knowledge to analyze linear systems with difference equations
3. To design and implement different structures of FIR and IIR filters.
4. To introduce about DSP processors and FFT processors.

COURSE OUTCOMES (CO)

Course Outcomes	Aligned Programme Outcomes (PO)
1. The students will be able to analyze the signals in both time and frequency domain	1, 2, 5, 10, 12
2. The student will be able to design FIR and IIR filters for signal pre-processing	1, 2, 5, 10, 12
3. The student will be able to implement and realize the filters using different structures and are able to select suitable DSP processors for signal processing applications	1, 2, 5, 10, 12

COURSE PLAN – PART II

COURSE OVERVIEW

Digital signal processing is widely used in audio and speech processing, telecommunications and biomedical engineering etc. It is one of the courses taught to students to enhance their knowledge in processing of signals in discrete and digital domain. The prerequisite of this course is signals and systems (ICPC16).

COURSE TEACHING AND LEARNING ACTIVITIES

S.No.	Week/Contact Hours	Topic	Mode of Delivery
1	1 and 2 (6 Contact hours)	Signal Processing Fundamentals: Discrete-time and digital signals, A/D, D/A conversion and Nyquist rate, Frequency aliasing due to sampling, Need for anti-aliasing filters.	Black/ white board
2	3, 4 and 5(7 Contact hours)	Discrete Time Fourier transform and frequency spectra, Spectral computation, Computational complexity of the DFT and the FFT, Algorithmic development and computational advantages of the FFT, Inverse FFT, Implementation of the FFT, Correlation of discrete-time signals. Discrete-time systems, Difference equations and the Z-transform, Analysis of discrete-time LTIL systems, Stability and Jury's test	Black/white board Power point presentation

3	6 and 7 (4 contact hour)	FIR Filters: Ideal digital filters, Realizability and filter specifications, Classification of linear phase FIR filters, Design using direct truncation, window methods and frequency sampling,	Black/white board Power point presentation
4	7 (1 contact hour)	Assessment –1: Written exam (20% Weightage)	
5	8 (3 contact hours)	Least-squares optimal FIR filters, Minimax optimal FIR filters	Black/white board Power point presentation
6	9 (3 contact hours)	Design of digital differentiators and Hilbert transformers, comparison of design methods	Black/white board Power point presentation
7	10 and 11 (6 contact hours)	IIR Filters: Design of analog prototype filters, Analog frequency transformations, Impulse invariance method and digital frequency transformations, Bilinear transformation	Black/white board Power point presentation
8	12 (2 contact hours)	Analog prototype to digital transformations, Difficulties in direct IIR filter design, Comparisons with FIR filters	Black/white board Power point presentation
9	13 (2 contact hours)	Filter Realization: Structures for FIR filters, Structures for IIR filters, State-space analysis and filter structures, Fixed point and floating-point representation of numbers	Black/white board Power point presentation
10	13 (1 contact hour)	Assessment –2: Written exam (20% Weightage)	-
11	14 (3 contact hours)	Errors resulting from rounding and truncating, Quantization effects of filter coefficients, Round-off effects of digital filters	Black/white board Power point presentation
12	15 and 16 (3 contact hours)	DSP Processors: Computer architectures for signal processing – Harvard architecture and pipelining, General purpose digital signal processors, Selection of DSPs	Black/white board Power point presentation
13	17 (3 contact hours)	hardware digital filters and hardware FFT processors, Evaluation boards for real-time DSP	Black/white board Power point presentation

COURSE ASSESSMENT METHODS

S.No.	Mode of Assessment	Week/Date	Duration	% Weightage
1.	First Assessment (written exam)	7th week	One hour	20%

2.	Assignment based on problems on Fourier transform and Z-transform	8th week	--	10%
3.	Second Assessment (Written Exam)	13th week	One hour	20%
4.	Compensation Assessment (Written Exam)-CPA	14th Week	One hour	20%
5.	Assignment or seminar based on specialized topics related to DSP Architectures and hardwares	15th week	---	10%
6.	Final assessment (Written Exam)	19th week	3 hour	40%

***mandatory; refer to guidelines on page 4**

COURSE EXIT SURVEY (mention the ways in which the feedback about the course shall be assessed)

1. Indirect feedback through questionnaire.
2. Direct feedback from the students.
3. Feedback from the students during the class committee meetings.

COURSE POLICY (preferred mode of correspondence with students, policy on attendance, compensation assessment, academic honesty and plagiarism etc.)

MODE OF CORRESPONDENCE (email/ phone etc.)

Any suggestions, Queries and feedback can be emailed to the Course Coordinator directly at pakarthick@nitt.edu

Course Policy

- Compensation Assessment: A student can be, upon prior approval, absent from only one out of the continuous assessments (1 or 3), for which he/she is allowed to take the compensatory assessment. Note that this assessment is not offered as an improvement test for everyone.

ATTENDANCE

- Cf. B.4.5.2 (page 7, https://www.nitt.edu/home/academics/rules/BTech_Regulations_2018.pdf) 75% attendance is mandatory, with an exemption up to 10% on genuine grounds (on-duty); prior information and approval from the instructor is compulsory.
- Students with less than 65% of attendance shall be prevented from writing the final assessment and shall be awarded 'V' grade.
- The only option for students with attendance < 65% is RE-DO.

ASSESSMENTS AND GRADING POLICY

- A student is declared pass upon accumulating a minimum of 35% over all the 5 assessments; grading is done for those students declared passed based on the class average – average and above shall get S, A, and B grades, and below average shall get C, D, and E.

ACADEMIC DISHONESTY & PLAGIARISM (cf. Institute Rules & Regulations)

- Possessing a mobile phone, carrying bits of paper, talking to other students, copying from others

during an assessment will be treated as punishable dishonesty.

- Zero mark to be awarded for the offenders. For copying from another student, both students get the same penalty of zero mark.
- The departmental disciplinary committee including the course faculty member, PAC chairperson and the HoD, as members shall verify the facts of the malpractice and award the punishment if the student is found guilty. The report shall be submitted to the Academic office.
- The above policy against academic dishonesty shall be applicable for all the programmes.

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ADDITIONAL INFORMATION

All the students are urged to be interactive during the classes; this is an essential component of the teaching-learning process. They are free to interact with me over email any time, and if needed meet me in person with prior appointment.

Any changes in the proposed layout of the semester, due to unavoidable circumstances, shall be intimated immediately to the students and to the Chairperson, PAC

FOR APPROVAL

Course Faculty	CC-Chairperson	HOD
(Dr. P. A. Karthick)	(Dr. D. Ezhilarasi)	(Dr. K. Dhanalakshmi)