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Multirate DSP

By Prof. R. David Koilpillai | IIT Madras

Learners enrolled: 1212

Introduction - Multirate DSP

The key features of this course includes the following topics• An in-depth understanding of sampling, reconstruction, sampling rate conversion using multirate building blocks • Applications of multirate DSP – Filter design, Filterbanks, Transmultiplexer, Delta-Sigma A/D • Mathematical framework for Perfect Reconstruction Filter banks• Achieving capacity in wireless channels, motivation for Multicarrier modulation, Redundancy via zero padding and cyclic prefix • Mathematical framework for OFDM and its extensions • Introduction to Wavelets and Multichannel filter banks• Matlab-based computer exercises to gain understanding of multirate DSP concepts and applications.

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INTENDED AU B.Tech/ M.E./ M.Tech/ Ph.D. students who have completed basic course in Digital Signal Processing

- Students planning to do projects / research in DSP
- Industry practitioners working with DSP audio and video products

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PRE-REQUISITES : Basic course in Digital Signal Processingl

INDUSTRY SUPPORT : Texas Instruments, Qualcomm, Broadcomm, Jasmine Infotech, Samsung, Sasken, Intel, Motorola, ittiam,
Redpine... Companies developing products based on DSP (audio, speech processing, image processing, biomedical and other areas)

Summary

Course Status :	Completed
Course Type :	Elective
uration :	12 weeks
Category :	∘ Electrical, Electronics and Communications Engineering
Credit Points :	3
Level :	Undergraduate/Postgraduate
Start Date :	27 Jan 2020
End Date :	17 Apr 2020
Enrollment Ends :	03 Feb 2020
Exam Date :	25 Apr 2020 IST

Note: This exam date is subjected to change based on seat availability. You can check final exam date on your hall ticket.

This is an AICTE approved FDP course

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(https://www.addtoany.com/share#url=https%3A%2F%2Fonlinecourses.nptel.ac.in%2Fnoc20_ee21%2Fpreview&title=Multirate%20DSP%20-%20Course)

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Course la (https://swayam.gov.in/) (https://swayam.gov.in/nc_details/NPTEL)

Week 1 : Introduction• Overview of Sampling and Reconstruction • Review Discrete-Time Systems, digital filters

Week 2 : Oversampling techniques, DT processing of continuous time signals

Week 3 : Fundamentals of Multi-rate Systems• Basic building blocks – Up sampling, down sampling, aliasing• Mathematical framework for sampling rate change

Week 4 : Sampling rate change and filtering, fractional sampling rate change

Week 5 : Interconnection of multirate DSP blocks, Multiplexer and Demultiplexer functionality, Polyphase decomposition, Noble Identities, efficient implementation of sampling rate conversion

Week 6 : Applications of Multirate DSP - DFT-based Filterbanks, Interpolated FIR filter design, Cascaded-Integrator-Comb (CIC) filters, Transmultiplexer, Filterbank interpretation of Spectral analysis using DFT

Week 7 : Two channel maximally decimated filter bank, Signal impairments - Aliasing, Magnitude distortion, Phase distortion, Aliasing cancellation

Week 8 : Allpass filters, properties, application in two channel filterbanks, Half-band filters, Power complementary filter pairs, Mth band filters, two channel perfection reconstruction filterbanks.

Week 9 : Capacity of wireless channels, Waterfilling method, motivation for Multicarrier modulation

Week 10 : Block transceivers with redundancy, Zero-padding, cyclic prefix, OFDM, extensions of OFDM incuding Filterbank Multicarrier (FBMC)

Week 11 : Application of Multirate DSP – Delta Sigma A/D conversion

Week 12 : Introduction to wavelets and M-channel perfect reconstruction filterbanks.

Books and references

Discrete-Time Signal Processing by Alan V. Oppenheim, Ronald W. Schafer, 3rd edition, 2016, Pearson, ISBN 978-93-325-3503-92. P. P. Vaidyanathan, "Multirate Systems and Filter Banks," Pearson, 2004, ISBN 81-297-0685-73. Lin, Phoong & Vaidyanathan, "Filter Bank Transceivers for OFDM and DMT Systems, Cambridge University Press, 2011, ISBN 978-1-107-00273-94. Norbert Fliege, "Multirate digital signal processing: multirate systems, filter banks, wavelets," Wiley, 1994, ISBN 978-04719397645. Frederic Harris, "Multirate Signal Processing for Communication Systems," Prentice Hall, 2004, ISBN 978-0131465114.

Instructor bio

Prof. R. David Koilpillai

IIT Madras

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R. David Koilp Tech degree in Electrical Engineering from the Indian Institute of Technology Madras and the M.S. and Ph.D. degrees in Electrical Engineering from the California Institute of Technology, Pasadena, CA. In June 2002, David joined the EE faculty of IIT Madras. He is currently the Qualcomm Institute Chair Professor in EE and Dean (Planning). During the period April 2008 – December 2009, he served as the Co-Chair of the IITM special Task Force for setting up the new IIT at Hyderabad. David also served as Head, Central Electronics Centre of IITM during 20010-11. David's technical areas of expertise include cellular and broadband wireless systems, and DSP techniques for wireless communications. He is the Faculty Coordinator of the IITMSAT Student Satellite initiative. During January – July 2007, David was on sabbatical from IITM and served as the Chief Scientist, Centre of Excellence in Wireless Technology (CEWiT), a public-private R&D initiative of the Govt. of India, and was responsible for launching the national project – Broadband Wireless Consortium of India (BWCI). Prior to joining IITM, David was at General Electric Corporate R&D for four years and Ericsson USA for eight years, where he held different technical and managerial positions. In 2000, he became the Director of the Ericsson's Advanced Technologies and Research Department at RTP, North Carolina, developing GPRS/EDGE handset technology. David's technical contributions at GE and Ericsson have resulted in 32 US patents, 10 Canadian Patents and 19 WIPO/European patents. In 1999 David received the "Ericsson Inventor of the Year" award, the highest technical recognition within Ericsson. In Nov 2003 David was elected Fellow of the Indian National Academy of Engineering. In 2014, David received the Srimathi Marti napurna Gurunath Award for Excellence in Teaching (Best Teacher Award of IIT Madras)David's current technical activities are in the areas of Cellular evolution - 4G and 5G, Smart grid Communications, DSP for High Speed Coherent optical communications

Course certificate

- The course is free to enroll and learn from. But if you want a certificate, you have to register and write the proctored exam conducted by us in person at any of the designated exam centres.
- The exam is optional for a fee of Rs 1000/- (Rupees one thousand only).
- **Date and Time of Exams:** 25th April 2020, Morning session 9am to 12 noon; Afternoon Session 2pm to 5pm.
- Registration url: Announcements will be made when the registration form is open for registrations.
- The online registration form has to be filled and the certification exam fee needs to be paid. More details will be made available when the exam registration form is published. If there are any changes, it will be mentioned then.
- Please check the form for more details on the cities where the exams will be held, the conditions you agree to when you fill the form etc.

CRITERIA TO GET A CERTIFICATE:

- Average assignment score = 25% of average of best 8 assignments out of the total 12 assignments given in the course.
- Exam score = 75% of the proctored certification exam score out of 100
- Final score = Average assignment score + Exam score

YOU WILL BE ELIGIBLE FOR A CERTIFICATE ONLY IF AVERAGE ASSIGNMENT SCORE >=10/25 AND EXAM SCORE >= 30/75.

- If one of the 2 criteria is not met, you will not get the certificate even if the Final score >= 40/100.
- Certificate will have your name, photograph and the score in the final exam with the breakup.It will have the logos of NPTEL and IIT Madras. It will be e-verifiable at nptel.ac.in/noc (http://nptel.ac.in/noc).
- Only the e-certificate will be made available. Hard copies will not be dispatched.

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NPTEL E-LEARNING COURSES FROM THE IITS & IISC

National Programme on Technology Enhanced Learning (NPTEL)

Receipt for successful payment of fees for online courses conducted by NPTEL
Course Run:Jan-Apr 2019

Name of candidate : **CHINDAM HARI PRASAD**

Courses name : **Multirate DSP**

Date of exam : **2019-04-27**

Mode of payment : **Billdesk**

Amount paid : **Rs.1100**

FDP Amount : **Rs.100**

We hereby acknowledge with thanks, the receipt of ***Rs.1200*** *from the afore-mentioned candidate towards payment for NPTEL Online Certification Exam, details of which are shown above.*

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Roll No: NPTEL19EE27S31452166

To
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AND SCIENCE (FOR WOMEN)
HYDERABAD

35/742

Score	Type of Certificate
>=90	Elite+Gold
75-89	Elite+Silver
>=60	Elite
40-59	Successfully completed the course
<40	No Certificate

No. of credits recommended by NPTEL:3

Elite

NPTEL Online Certification

(Funded by the Ministry of HRD, Govt. of India)

This certificate is awarded to

CHINDAM HARI PRASAD

for successfully completing the course

Multirate DSP

with a consolidated score of **65** %

Online Assignments	18.03/25	Proctored Exam	46.88/75

Total number of candidates certified in this course: **57**

Prof. A. Ramesh
Chairman
Centre for Continuing Education, IITM

Jan-Apr 2019
(12 week course)

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Prof. Andrew Thangaraj
NPTEL Coordinator
IIT Madras

Indian Institute of Technology Madras

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Roll No:NPTEL19EE27S31452166

To CHINDAM HARI PRASAD
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No. of weeks of NPTEL Courses	Equivalence of NPTEL course with regular FDP
4	$\frac{1}{2}$ FDP of one week
8	Full FDP of one week
12	$1\frac{1}{2}$ FDP

Duration of NPTEL course: 12 Weeks

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Prof. Andrew Thangaraj
NPTEL Coordinator
IIT Madras

(Jan-Apr 2019)

Prof. Dileep N. Malkhede
Advisor-I (Research, Institute & Faculty Development)
All India Council for Technical Education

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To validate and check scores: http://nptel.ac.in/noc

The candidate has studied the above course through MOOCs mode, has submitted online assignments and passed proctored exams.
This certificate is therefore acceptable for promotions under CAS as per AICTE notifications dated 24th July 2018, similar to other refresher / orientation courses.
F.No. AICTE / RIFD / FDP through MOOCs / 2017-18

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Department: Electronics and Communication Engineering
2019-20
REPORT
Course Title: Multirate DSP (Digital Signal Processing)

Institution: NPTEL (National Programme on Technology Enhanced Learning)
Course Overview:
Duration: 12 weeks
Type: Online Course
Level: Undergraduate/Postgraduate

Course Content Highlights:
Introduction to Multirate Signal Processing
Multirate Filter Banks and Polyphase Structures
Down sampling and Up sampling Techniques
Decimation and Interpolation in Signal Processing
Design and Implementation of Multirate Filters
Applications in Communication Systems and Image Processing Upon completing the Multirate DSP course, participants are expected to:
Comprehend Multirate Signal Processing: Understand the fundamental concepts, principles, and applications of Multirate DSP in various domains.
Apply Techniques: Apply down sampling, up sampling, decimation, and interpolation techniques effectively in signal processing problems.
Design and Implement Filters: Demonstrate the ability to design and implement Multirate filters using polyphase structures.
Analyze Applications: Analyze and evaluate the application of Multirate DSP in communication systems and image processing.
Problem-solving Skills: Develop problem-solving skills by applying Multirate signal processing techniques to practical scenarios.
Enhance Understanding: Deepen the understanding of advanced DSP concepts and their significance in real-world applications.

Signature of the Faculty

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