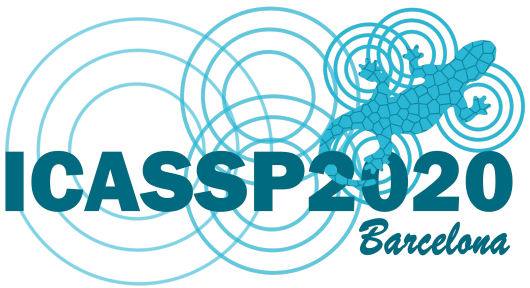



# Teaching Signals and Systems- A First Course in Signal Processing

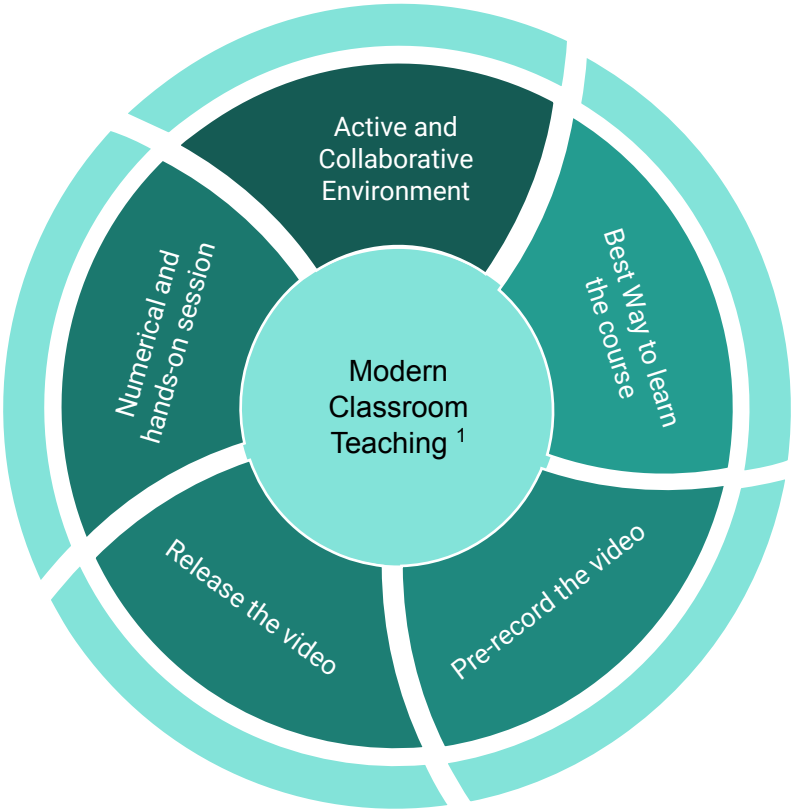
Authors: Nikhar P Rakhashia, Ankit A Bhurane, Vikram M Gadre

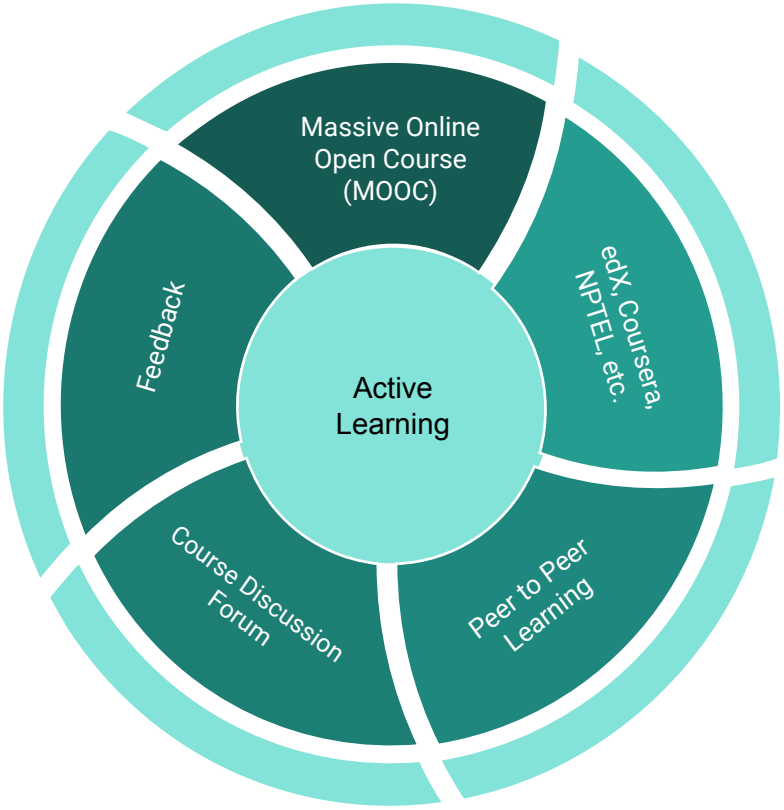
Presented by: Nikhar P Rakhashia

# Overview

- Active Learning Approaches
- MOOC on Signals and Systems
- Course Components
- Course Evaluation
- Beyond the Course

# Active Learning Approaches





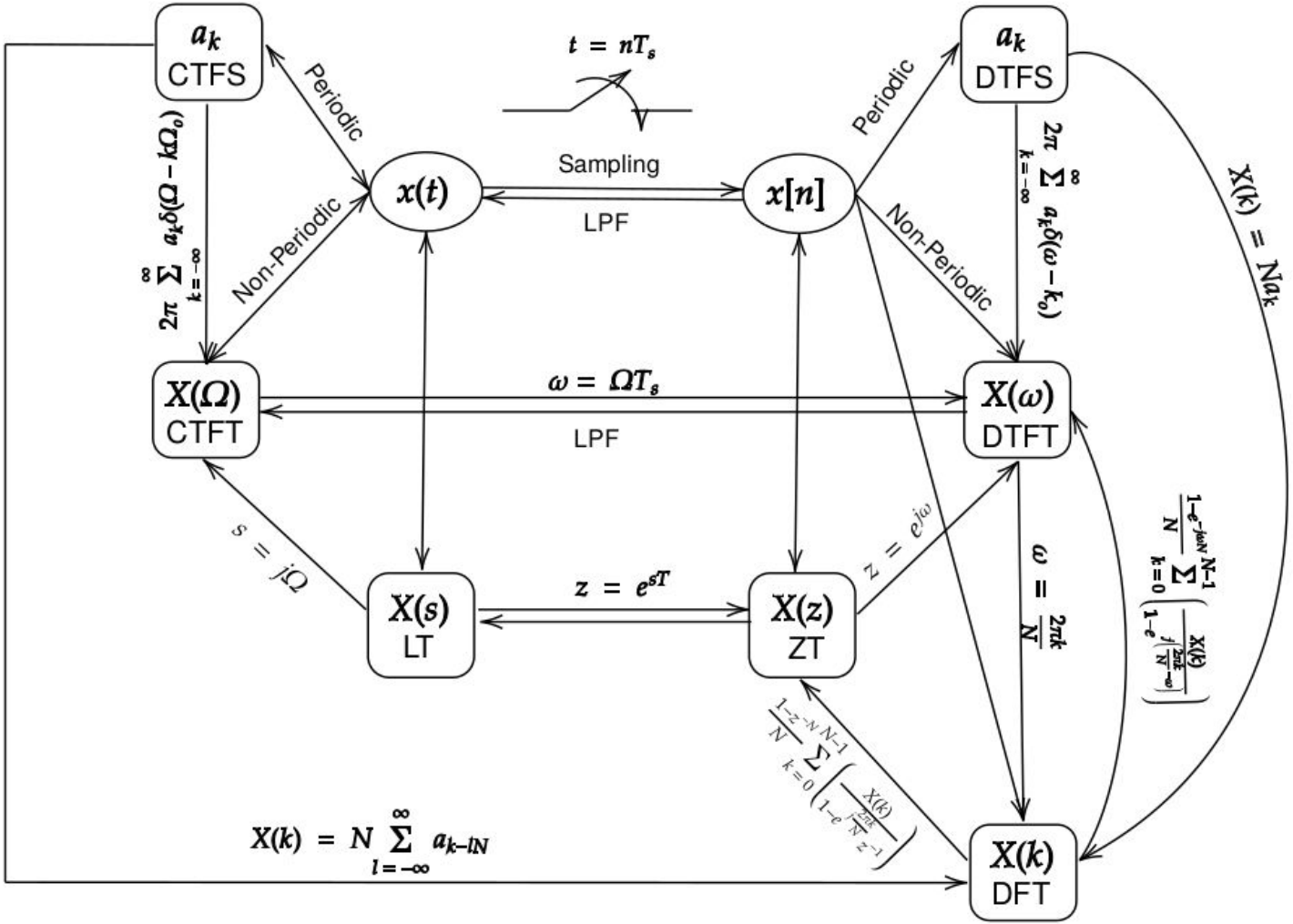

1. Maureen J. Lage, Glenn J. Platt, and Michael Treglia, “Inverting the classroom: A gateway to creating an inclusive learning environment,” The Journal of Economic Education, vol. 31, no. 1, pp. 30–43, 2000

# MOOC on Signals and Systems

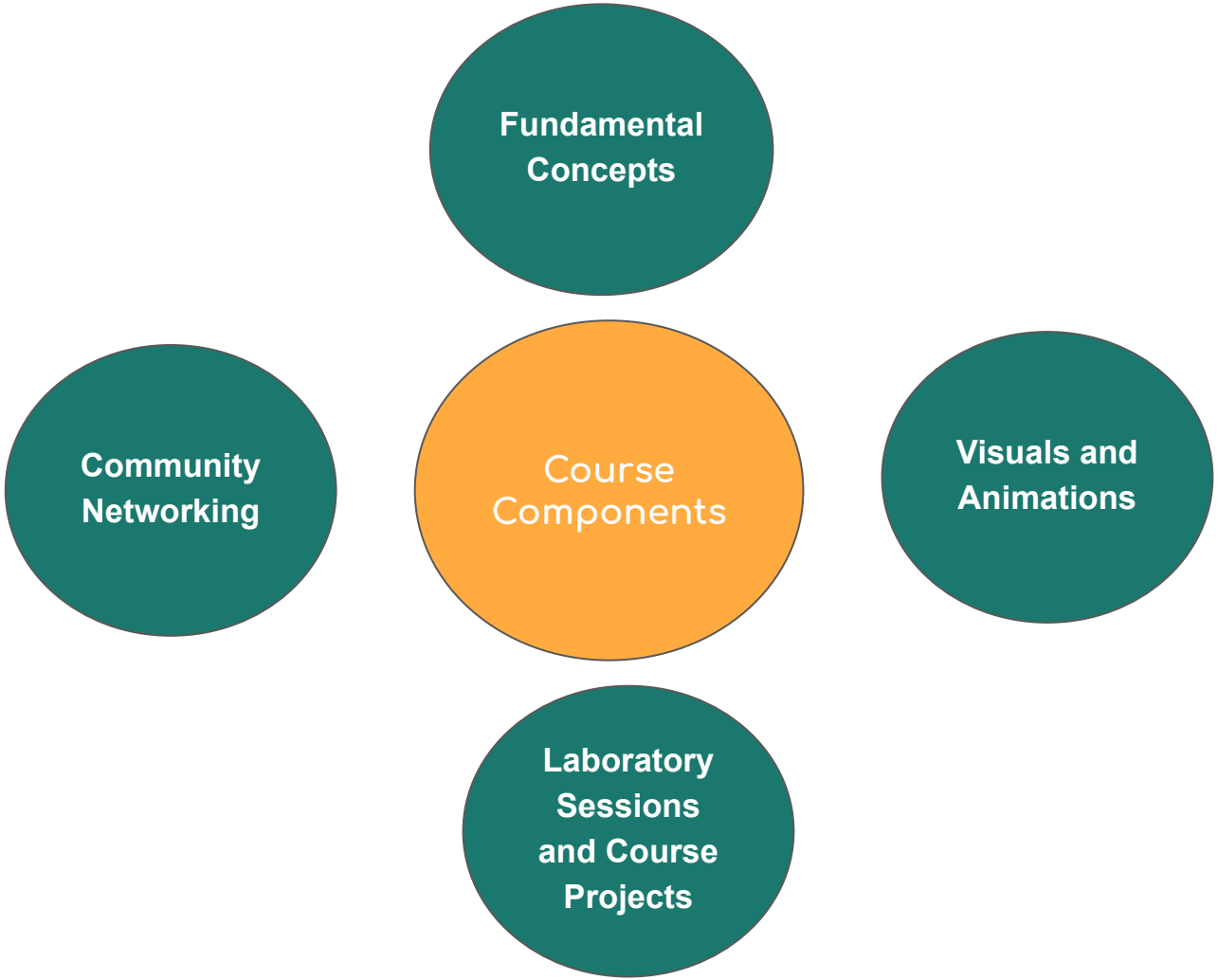
- This course is a blend of mathematical tools and engineering concepts
- IIT Bombay offers the MOOC on Signals and Systems in two parts namely:
  - EE 210.1x (Introduction, LTI systems, Fourier Transform)[1]
  - EE 210.2x (Sampling and reconstruction, DTFT, Laplace Transform, z- Transform)[2]
- Learning Outcomes:
  - Manipulation
  - Analysis
  - Comparison
  - Applications

1. https://courses.edx.org/courses/course-v1:IITBombayX+EE210.1x+1T2018a/course/

2. https://courses.edx.org/courses/course-v1:IITBombayX+EE210.2x+1T2018/course/



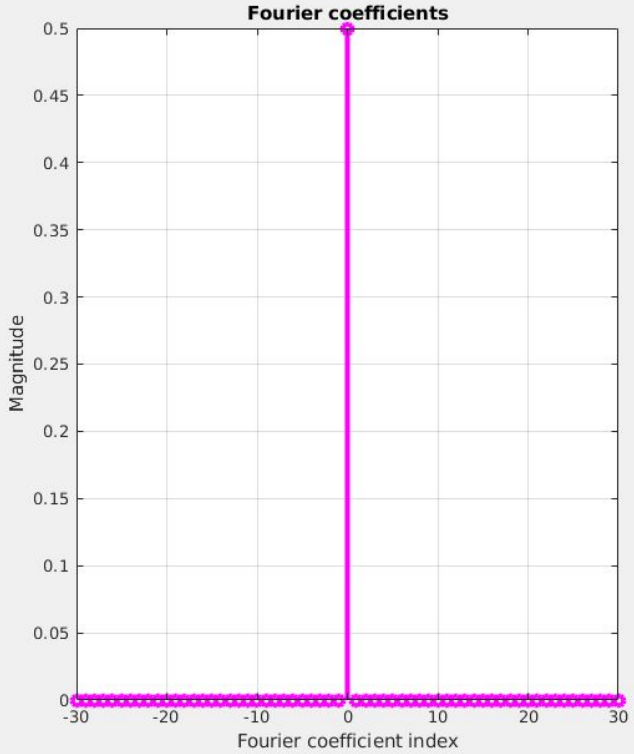

Interconnection between domain transformation tools

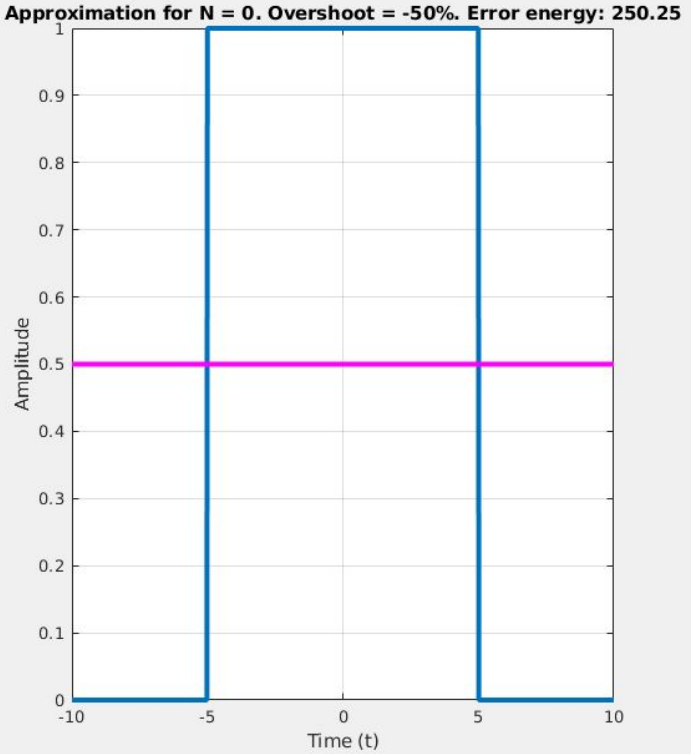

Fundamental Concepts
Community Networking
Course Components
Visuals and Animations
Laboratory Sessions and Course Projects

# Basic questions in Signals and Systems

- Why is a domain transformation required?
- What is the need of complex analysis in the real world?
- Why are complex exponentials used as a basis?
- Why are different transformation techniques required?
- What are the applications of LTI and non-LTI systems?

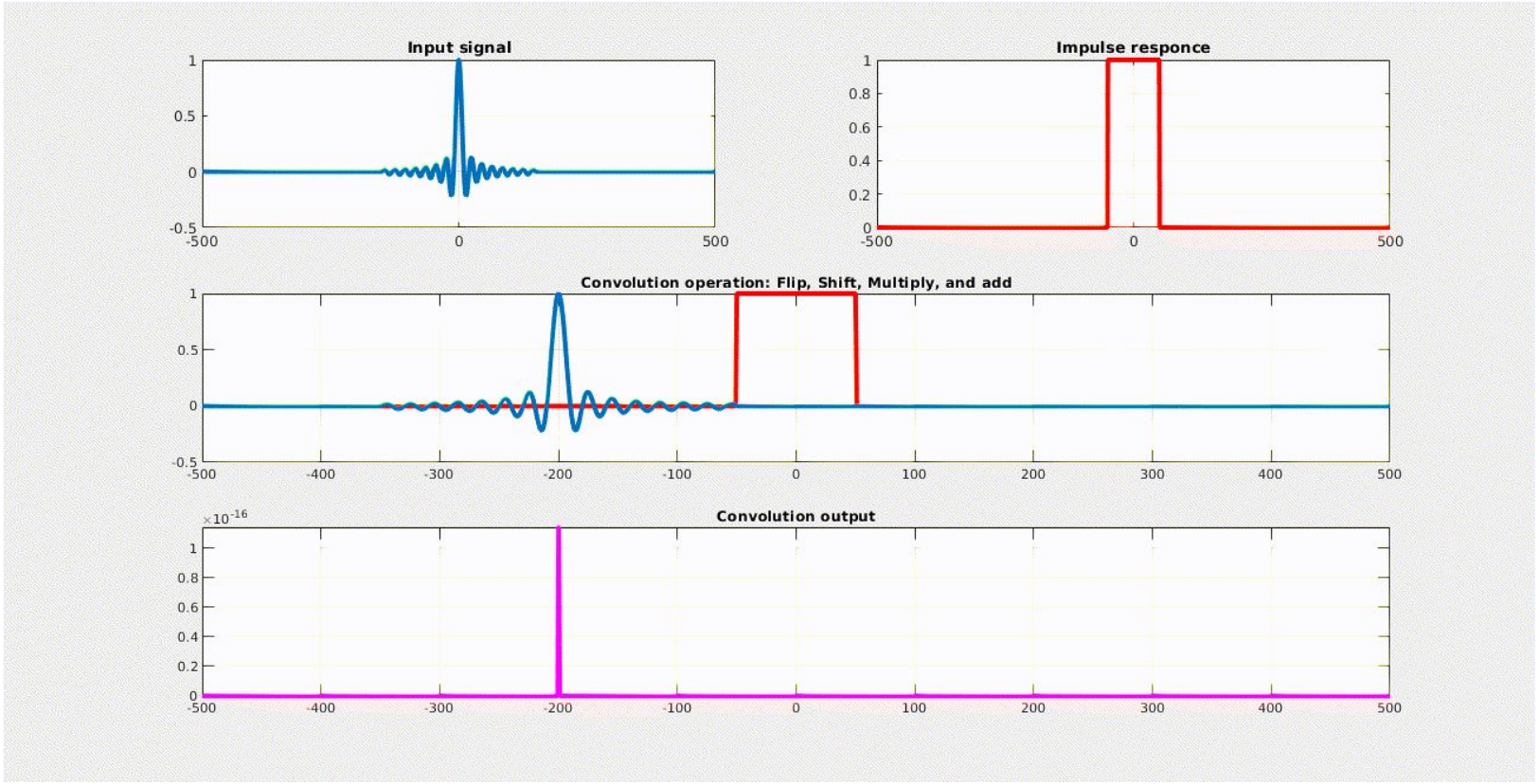
# Visuals and Animations




# Fourier series synthesis

Ankit A. Bhurane,“Fourier series of square wave. demo of gibbs phenomenon with over-shoot calculation,”
https://in.mathworks.com/matlabcentral/fileexchange/43590-fourier-series-of-square-wave-demo-of-gibbs-phenomenon-with-overshoot-calculation



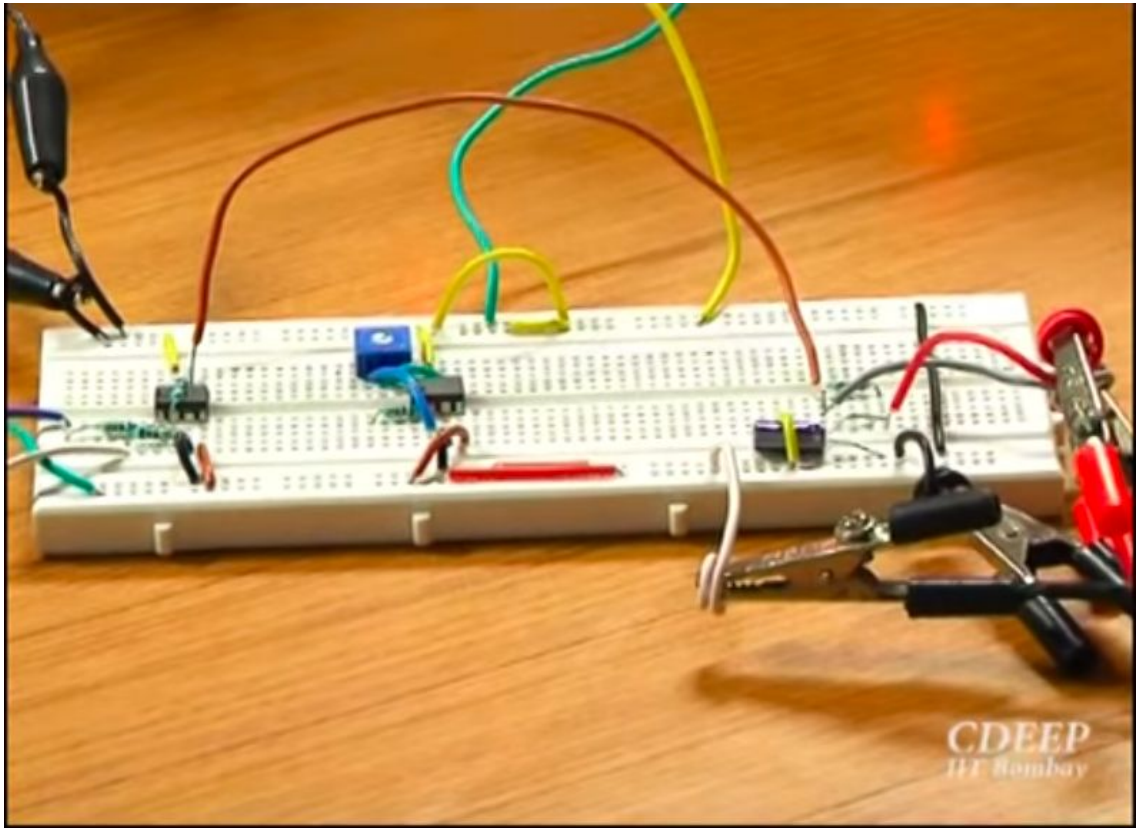

# Example of convolution operation

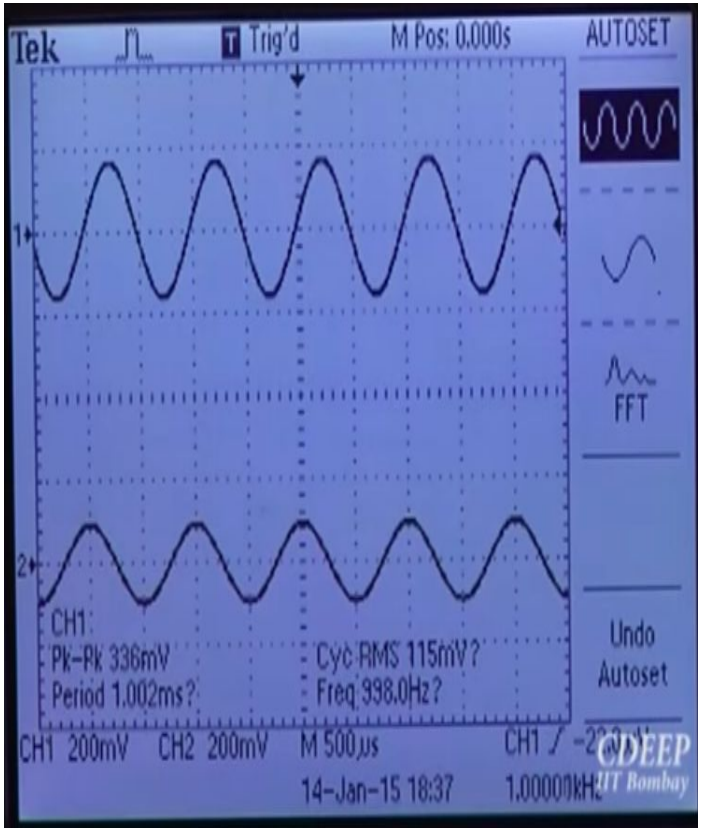
Ankit A. Bhurane (2020). Demonstration of Convolution operation, graphically (https://www.mathworks.com/matlabcentral/fileexchange/43642-demonstration-of-convolution-operation-graphically)

# Laboratory Sessions

Example

- Aim: Learn Basic signal operations along independent and dependent variables.
- Task: recording one's voice, plotting and hearing it.
- Concepts:
  - scaling along the dependent axis refers to amplification or attenuation
  - scaling along the independent axis refers to slower or faster playback.




# Demonstration of the homogeneity property



https://courses.edx.org/courses/course-v1:IITBombayX+EE210.1x+1T2018a/courseware/293df9ef329c45e18d903fb1fc4c69c1/6c80a49279fe46c995ed4559c7085579/?activate_block_id=block-v1%3AIITBombayX%2BEE210.1x%2B1T2018a%2Btype%40sequential%2Bblock%406c80a49279fe46c995ed4559c7085579

# Course Project

- Building a music equalizer or photo editing application using cloud platforms
- Simulation, calibration and optimization of aerodynamic models
- Developing systems to diagnose diseases using machine learning tools

# Community Networking

## Conferences

SPCOM
GlobalSIP
ICASSP
ICIP

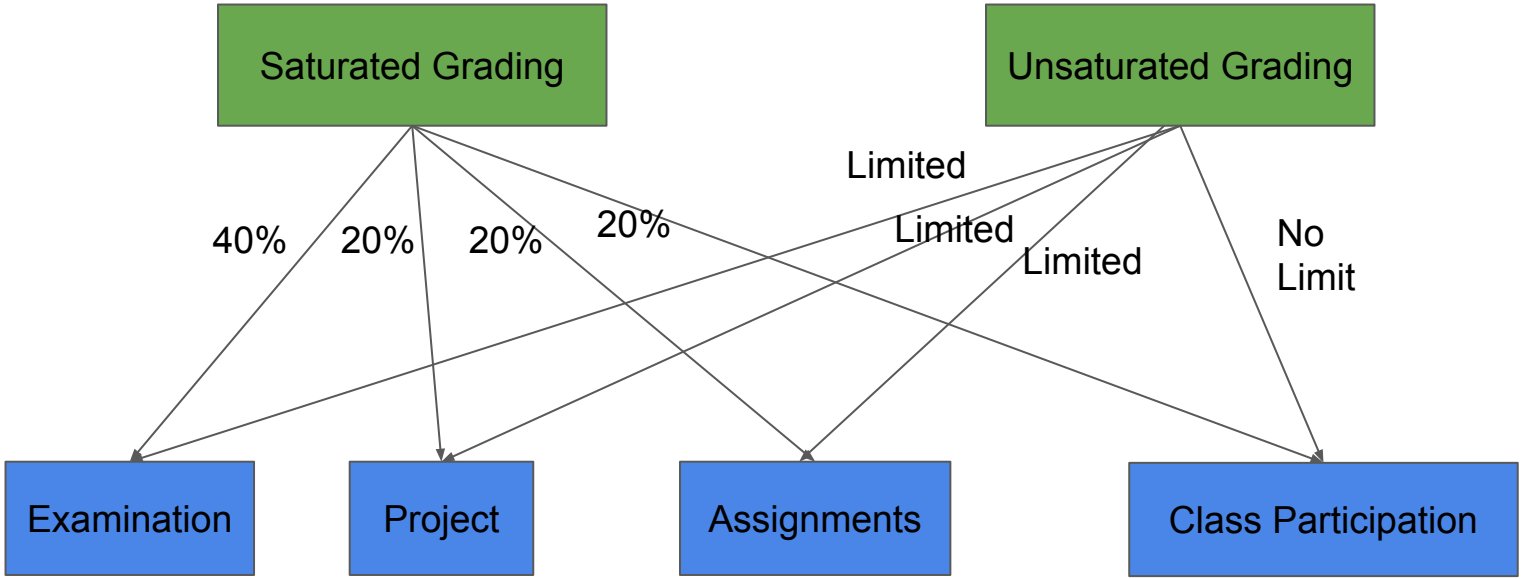
## Social Platforms and Q&A Communities

Mendeley
Researchgate
DSP Stack Exchange
Stack Overflow
Academia

## Indexing Platforms

Elsevier
IEEE Xplore
Springer

# Course Evaluation



# Beyond the course

- Limitations of domain transformation tools
- Fourier Analysis: inability to distinguish time-varying frequency components
- Explore time-frequency methods such as short-time Fourier Transform
- The new principles can be demonstrated analytically and through simulations.
- Concepts of sampling and band-pass filters: Reconstruction filter banks

# Conclusion

- Signals and systems: useful irrespective of the disciplines of engineering
- Basic building blocks for analysis and synthesis of systems
- Role of abstraction, visualizations and interconnection of tools
- Holistic approach: focus on lab sessions, project, research along with theory

# Thank you

# References


- Jonathan Bergmann and Aaron Sams,Flip your classroom: Reach every student in every class every day, International society for technology in education, 2012
- Barry Van Veen, “Flipping signal-processing instruction[sp education],”IEEE Signal Processing Magazine, vol.30, no. 6, pp. 145–150, 2013
- Maureen J. Lage, Glenn J. Platt, and Michael Treglia,“Inverting the classroom: A gateway to creating an inclusive learning environment,”The Journal of Economic Education, vol. 31, no. 1, pp. 30–43, 2000
- Philip J Guo, Juho Kim, and Rob Rubin, “How video production affects student engagement: An empirical study of mooc videos,”in Proceedings of the first ACM conference on Learning@ scale conference. ACM,2014, pp. 41–50
- John Kerr, Suzy Houston, Leah Marks, and Athene Richford, “Building and executing moocs: A practical review of glasgow’s first two moocs (massive open online courses),” 2015
- EE 210.1x, “Signals and systems, part 1, ”https://courses.edx.org/courses/course-v1:IITBombayX+EE210.1x+1T2018a/course/ [Accessed: 15 Apr 2020]
- EE 210.2x, “Signals and systems, part 2, ”https://courses.edx.org/courses/course-v1:IITBombayX+EE210.2x+1T2018/course/ [Accessed: 15 Apr 2020]
- Ankit A. Bhurane,“Fourier series of square wave. demo of gibbs phenomenon with overshoot calculation,”https://in.mathworks.com/matlabcentral/fileexchange/43590-fourier-series-of-square-wave_-demo-of-gibbs-phenomenon-with_-overshoot-calculation [Accessed: 15 Apr 2020]

# References


- Amro,“Fourier series representation of periodic signals,”https://gist.github.com/amroamroamro/617305c05001caffc8d0[ Accessed: 15 Apr 2020]
- Ankit A. Bhurane, “Demonstration showing importance of phase in images” https://in.mathworks.com/matlabcentral/fileexchange/43645-demonstration-showing-importance_-of-phase-in-image [Accessed: 15 Apr 2020]
- B. L. Sturm and J. D. Gibson,“Signals and systems using matlab: an integrated suite of applications for exploring and teaching media signal processing,” in Proceedings Frontiers in Education 35th Annual Conference, Oct 2005, pp. F2E–21
- M.R. Lovejoy and M. A. Wickert, “Using the ipython notebook as the computing platform for signals and systems courses,” in 2015 IEEE Signal Processing and Signal Processing Education Workshop (SP/SPE), Aug 2015,pp. 289–294
- Stack Exchange,“Signal processing stack exchange,”https://dsp.stackexchange.com/ [Accessed: 15 Apr 2020]
- Stack Overflow,“Stack overflow,”https://stackoverflow.com/ [Accessed: 15 Apr 2020]
- A. Gupta and A. Farswan, “Rethinking teaching practices for signal processing education,” in ICASSP 2019- 2019 IEEE International Conference on Acoustics,Speech and Signal Processing (ICASSP), May 2019, pp.7878–7882.
- Wynne Harlen and Mary James, “Assessment and learning: Differences and relationships between formative and summative assessment,”Assessment in Education,vol. 4, pp. 365–379, 11 1997