



# CCO50 - Digital Speech Processing (2023)

course syllabus and details

São Paulo State University (UNESP), Institute of Biosciences, Letters and Exact Sciences (IBILCE), Department of Computer Science and Statistics (DCCE), 2265 Cristóvão Colombo St., 15054-000, São José do Rio Preto, State of São Paulo, Brazil.

[**Instructor**]: Prof Dr Eng Rodrigo Capobianco Guido [guido@ieee.org](mailto:guido@ieee.org)

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[**Term**]: 2025 - Fridays - morning - [on-line version]

[**Syllabus**]: (1) Elements of signals and systems: analog and digital signals, odd and even signals, periodic and aperiodic signals, sampling and quantization, linear-time invariant systems, discrete convolution, transfer functions, Fourier analysis, Z Transform, time and frequency domains, windows and digital filter design considering finite (FIR) and infinite (IIR) impulse responses; (2) Speech production and the vocal apparatus: periodic and aperiodic excitation, voiced and unvoiced sounds, resonators and formant frequencies, cepstrum, Hilbert transform; (3) Speech perception: auditory system in humans, Bark and Mel scales; (4) Applications involving modern algorithms and techniques for speech analysis, including voice activity detection, speech recognition, speaker identification, speaker verification and spoof detection, speech emotion recognition and speech enhancement. Details on features and classifiers: handcrafted extraction versus feature learning with autoencoders, convenient features, paraconsistent feature ranking, shallow and deep classifiers such as distances, perceptrons, hidden Markov models, support vector machines, deep belief networks, among others; (5) Topics on modern algorithms and techniques for speech synthesis, speech compression and voice conversion, among other applications.

[**Suggested Bibliography**]:

## Books:

HAYKIN, S.; VEEN, B.V. **Signals and Systems**. 2.ed. Wiley, 2002.

LYONS, R. **Understanding Digital Signal Processing**, Prentice Hall, 3.ed., 2011.

OPPENHEIM, A. **Discrete-Time Signal Processing**, Prentice-Hall, 3.ed., 2014.

HAYES, M.H. **Digital Signal Processing**. McGrawHill, 1999.

DENG, L.; O'SHAUGHNESSY, O. **Speech Processing: A Dynamic and Optimization-Oriented Approach**. Marcel Dekker Inc, 2003.

CHOU, W.; JUANG, B.H. **Pattern Recognition in Speech and Language Processing**. CRC Press, 2003.

QUATIERI, T.F. **Discrete-Time Speech Signal Processing**. Prentice Hall, 2002.

BEIGI, H. **Fundamentals of Speaker Recognition**. Springer, 2011.

SINGH, R. **Profiling Human from their Voice**. Springer, 2019.

HARRINGTON, J.; CASSIDY, S. **Techniques in Speech Acoustics**. Kluwer, 1999.

COLEMAN, J. **Introducing Speech and Language Processing**. Cambridge University Press, 2005.

CHEN, J.C. **Elements of Human Voice**. World Scientific, 2016.

WATANABE, S. et. al. **New Era for Robust Speech Recognition: exploiting deep learning**. Springer, 2017.

## Research Articles:

GUIDO, R.C. Enhancing Teager Energy Operator Based on a Novel and Appealing Concept: signal mass. *Journal of the Franklin Institute*. v.356, n.4, pp.2346-2352, (2019).

GUIDO, R.C. Paraconsistent Feature Engineering. *IEEE Signal Processing Magazine*. v.36, n.1, pp. 154-158, (2019).

GUIDO, R.C. A Tutorial-review on Entropy-based Handcrafted Feature Extraction for Information Fusion. *Information Fusion*, n.41, pp.161-175, (2018)

GUIDO, R.C. ZCR-aided Neurocomputing: a study with applications. *Knowledge-based Systems*, v. 105, pp. 248-269, (2016).

GUIDO, R.C. A Tutorial on Signal Energy and its Applications. *Neurocomputing*, v. 179, pp.264-282, (2016).

**[Grading Activities]:** The final grade, i.e., A, B, C or R, will be based on the following activities:

- **20%:** virtual class attendance, participation, group collaboration, and so on;
- **50%:** twelve "short tests" (ST);
- **30%:** final term exam.

where:

- A: 86 ~ 100% ;
- B: 70 ~ 85% ;
- C: 50 ~ 69% ;
- R: < 50% .

## **[Time Table]:**

- March 14: first class + ST1 [*ST is due prior to the next class*]
- March 21: **no class!!!!**
- March 28: class + ST2 [*ST is due prior to the next class*]
- April 04: class + ST3 [*ST is due prior to the next class*]
- April 11: class + ST4 [*ST is due prior to the next class*]
- April 18: **holiday - no class**
- April 25: class + ST5 [*ST is due prior to the next class*]
- May 02: **holiday - no class**
- May 09: class + ST6 [*ST is due prior to the next class*]
- May 16: class + ST7 [*ST is due prior to the next class*]
- May 23: class + ST8 [*ST is due prior to the next class*]
- May 30: class + ST9 [*ST is due prior to the next class*]
- June 06: class + ST10 [*ST is due prior to the next class*]
- June 13: class + ST11 [*ST is due prior to the next class*]
- June 20: **holiday - no class**
- June 27: class + ST12 - this is the **last class** [*ST is due prior to July 04*]
- July 04: **no class!!!! Final term exam, to be sent by email, is due!!!**