Department of Electronic and Telecommunication Engineering
The University of Moratuwa, Sri Lanka

EN1020 Circuits, Signals, and Systems

Course Outline—January 2026

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1 Introduction

Signals and systems find many application in communications, automatic control, and form the basis for signal processing, communication, machine vision, and pattern recognition. Electrical signals (voltages and currents in circuits, electromagnetic communication signals), acoustic signals, image and video signals, and biological signals are all examples of signals that we encounter. They are functions of independent variables and carry information. We define a system as a mathematical relationship between an input signal and an output signal. We can use systems to analyze and modify signals. We can realize any systems using electrical and electronic circuits (in addition to other systems like mechanical systems): The theoretical analysis that we do manifests in such circuits. Circuits, Signals, and systems have brought about revolutionary changes. In this course we will study the fundamentals of circuits, signals, and systems. Types of signals in continuous time and discrete time, linear time-invariant (LTI) systems, Fourier series analysis and realizing these systems in circuits are the core components of the course.

Modules such as Signals and Systems, Digital Signal Processing, and many modules in the telecommunications pathway build on the fundamental knowledge that we would gain from this course module.

2 Learning Outcomes

After completing this course you will be able to do the following:

- Explain the fundamental tools in electrical circuit analysis.
- Apply network theorems in analysing electrical circuits.
- Differentiate between continuous-time, discrete-time and digital signals, and techniques applicable to the analysis of each type.
- Use Fourier series techniques to understand frequency domain characteristics of signals.
- Apply appropriate theoretical principles to characterize the behaviour of Linear Time Invariant (LTI) systems.

3 Contents

1. Circuit Theory

   Circuit vs. wavelength, circuit as a graph/network. Charge, current, voltage, power, and energy. units of measurement. LTI resistor, capacitor, and inductor. KCL and KVL. Ideal current and voltage sources, dependent sources, device modelling, RLC transient solutions using differential equations, concepts of transients vs. steady state. Resonance, mutual inductance, electromagnetic coupling, and analysis. Transformer as a coupled element.

2. Circuit Analysis Using Network Theorems

Ground as a node, nodal analysis, Y matrix, node voltage and stimulus vector, super nodes, mesh analysis. Network theorems: superposition, Thevenin's, Norton's, Millman's. Source transformation and network equivalence, source transportation, substitution theorem, maximum power transfer, $Y-\Delta$ transformation. Two-port theory: impedance, admittance, hybrid, and ABCD parameters.

3. Introduction to Signals and Systems

   Classification of signals as continuous-time, discrete-time and digital. Introduction to impulse and step functions. Introduction to systems and input-output relationships. Simple classes of signals such as sinusoid and exponential signals. Characterizing Linear Time-Invariant (LTI) systems. Overview of the analysis techniques applicable to each type of signal/system and their interrelationships.

4. Fourier Series

   Overview of Fourier analysis as the representation of signals with complex sinusoids. The Fourier series representation of periodic signals. Properties of the Fourier series. Characterizing LTI systems in the frequency domain. Introduction to Fourier transform.

5. Introduction to Fourier Transform

   Continuous-time Fourier transform, development of the Fourier transform representation, the Fourier transform for periodic signals.

6. Linear Time-Invariant (LTI) Systems

   Characteristics of LTI systems. Characterizing the input-output relationship of continuous- and discrete-time LTI systems in the time domain. The convolution theorem and its application to LTI systems. RLC circuit an LTI system.

4 Prerequisites

Calculus.

5 Contact Hours, Course Material, Etc.

Instructors:	Dr. Ranga Rodrigo. Electronics Building, Room 111. ranga@uom.lk, 011 264 0422. Dr. Upeka Premaratne. Electronics Building upeka@uom.lk.
Teaching assistant:	Ms. Sanjana Kapukotuwa. Electronics Building sanjanakapukotuwa123@gmail.com
Lectures:	2 hours per week: Tuesdays 8:15 am. to 10:15 am.
Tutorials:	Every Wednesday from 3:15 pm. to 5:15 pm. (This will be notified in advance.)
Labs:	As scheduled in EN1094.
Office hours (drop in):	Please call me to set up an online appointment due to the current situation. Set up an appointment if you wish to meet outside office hours.
Moodle page	https://online.uom.lk/course/view.php?id=31201

6 Evaluation Scheme

Item	Date	Weight	Minimum
In-class quizzes (5 out of 8)	Surprise	20%	50%
Mid-semester examination	12 March 2025	20%	50%
Final examination	To be scheduled	60%	50%

7 Schedule

References

[1] A. V. Oppenheim and A. S. Willsky, *Signals and Systems*, 2nd ed. Englewood Cliffs, New Jersey: Prentice Hall, 1997.

[2] H. P. Hsu, *Schaum's Outline of Signals and Systems*. McGraw-Hill, 1995.