Laboratory Exercise 01
Introduction to Digital Signal Processing

Question 1: What do you mean by the term digital? Explain briefly.

In signals and systems, the term 'digital' is used to describe entities that are defined at discrete, finite instances of some independent variable (usually time) and have one of a finite set of values at each of these instances.

A digital signal is therefore both discrete time and discrete valued, and an entity that processes one or more digital input signals to produce a digital output signal is a digital system.

Figure 01 illustrates the difference between digital and analog signals as well as intermediate variants (discrete time, continuous value and continuous time, discrete value signals).
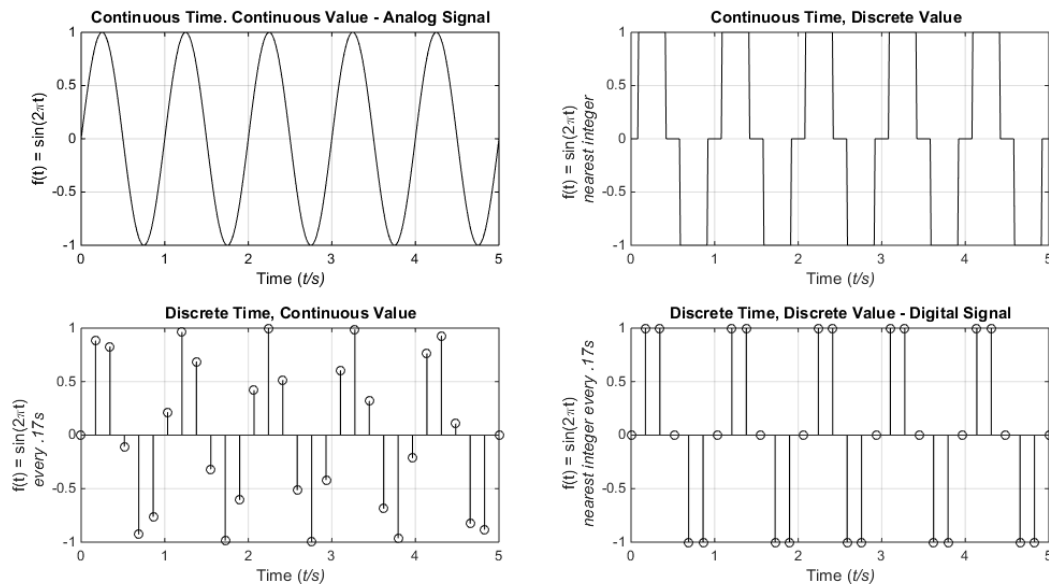

Figure 01: Analog and Digital Signals along with intermediate variants

Question 2: Write some (at least three) applications of DSP related to electrical engineering.

Digital Signal Processing (DSP) has many applications in electrical engineering, some of which are listed below.

- **Digital communication systems**: television, radio, mobile, and internet signals rely on DSP principles for encoding, transmission, modulation, and demodulation.
- **Instrumentation**: DACs in digital instruments provide an inexpensive, reliable, and robust way to measure, record, and analyse analog physical quantities.

- **Audio analysis**: DSP algorithms are at the heart of filtering, tuning, amplification, and other operations performed in audio analysis.
- **Speech recognition**: discrete Fourier transforms, a fundamental DSP tool, coupled with other frequency analysis techniques allow for the extraction and analysis of speech from audio signals.
- **Smart grids**: digital control systems use DSP techniques to optimise power generation and load management in real time.
- **Computer design**: the simplicity of designing circuits to deal with digital, rather than analog, electrical signals has given rise to sophisticated digital computers that are the backbone of almost every electrical engineering application.
- **Autonomous systems**: DSP is used for acquiring and manipulating system data that can be used in conjunction with statistical learning and neural networks to modify system behaviour and parameters without explicitly programming the system to do so.