Digital Signal Processing - Syllabus (B.Sc. Engineering)

1. Introduction to DSP

- Analog vs. Digital Signals
- Applications of DSP in real-world systems (audio, communication, biomedical, etc.)
- Advantages of DSP over analog processing

2. Discrete-Time Signals and Systems

- Classification of signals (periodic, aperiodic, energy, power)
- Discrete-time systems (linear, time-invariant, causal, stable)
- Impulse response and convolution
- Difference equations

3. Z-Transform

- Definition and Region of Convergence (ROC)
- Properties of Z-transform
- Inverse Z-transform
- Analysis of LTI systems using Z-transform
- Stability and causality in Z-domain

4. Discrete Fourier Transform (DFT) and Fast Fourier Transform (FFT)

- DFT: Definition, properties, computation
- Circular convolution
- Linear convolution using DFT
- FFT algorithms: Radix-2 DIT and DIF

5. Digital Filter Design

- FIR Filters
- Characteristics
- Windowing method
- Frequency sampling method
- IIR Filters
- Analog filter approximations (Butterworth, Chebyshev)
- Bilinear transform and impulse invariance

6. Sampling and Reconstruction

- Sampling theorem
- Aliasing
- Anti-aliasing filters
- Quantization

- Reconstruction of signals from samples

7. Multirate Signal Processing (Advanced/Optional)

- Decimation and Interpolation
- Sampling rate conversion
- Applications in compression and communication

8. DSP Processors and Real-Time Processing

- Basics of DSP hardware
- Introduction to real-time DSP implementation
- Applications in embedded systems

9. Laboratory and Projects

- Signal generation, visualization (using MATLAB or Python)
- FFT, filtering in time and frequency domains
- Audio signal analysis
- Implementation of filters

10. Applications of DSP

- Audio and speech processing
- Biomedical signal processing (e.g., ECG)
- Image processing fundamentals
- Wireless and communication systems