EOPE3011 SENSOR SIGNAL PROCESSING (3-0-0)

Course Objectives:
This course covers sensor characteristics, analog and digital signal conditioning, noise reduction, sampling, filtering, ADCs, and modern processing techniques applied to sensor outputs. Students will gain the ability to process real-world signals and design robust measurement and monitoring pipelines.

Module-IIntroduction to Sensors & Signals (6 Hours)
Sensor types, Static and dynamic characteristics, Calibration techniques, Sensitivity analysis, Hysteresis effects.

Module-IIAnalog Signal Conditioning (06 hours)
Instrumentation amplifiers, RC and active filter design, Noise sources, Shielding and grounding, Noise mitigation strategies.

Module-IIIDigital Signal Conditioning (06 hours)
Sampling theorem and aliasing, Quantization noise, ADC types including SAR, Sigma-Delta, and Flash architectures, DAC principles and nonlinearities.

Module-IVSignal Processing for Sensors (06 hours)
Discrete-time signal operations, FIR and IIR filter design, Filter stability analysis, FFT-based spectral analysis, and Correlation and averaging techniques.

Module-VAdvanced Sensor Signal Processing (06 hours)
Sensor fusion fundamentals, Weighted averaging, Complementary filtering, Introduction to Kalman filtering, Adaptive filtering, Case studies including IoT, wearable devices, and biomedical sensors.

Course Outcomes:
CO1 Demonstrate understanding of sensor behavior, calibration, and response analysis.
CO2 Design analog signal-conditioning circuits for measurement applications.
CO3 Apply sampling, quantization, and ADC/DAC techniques to digital systems.
CO4 Implement FIR/IIR filters and perform spectral analysis using FFT.
CO5 Utilize sensor fusion and estimation methods for multi-sensor applications.

Text Books:
1. Sensors and Signal Conditioning - Pallas-Areny & Webster
2. Measurement and Instrumentation Principles - Alan S. Morris
3. Digital Signal Processing - Proakis& Manolakis

References:
1. Signals and Systems - Oppenheim & Schafer
2. Random Data: Analysis and Measurement Procedures - Bendat& Piersol