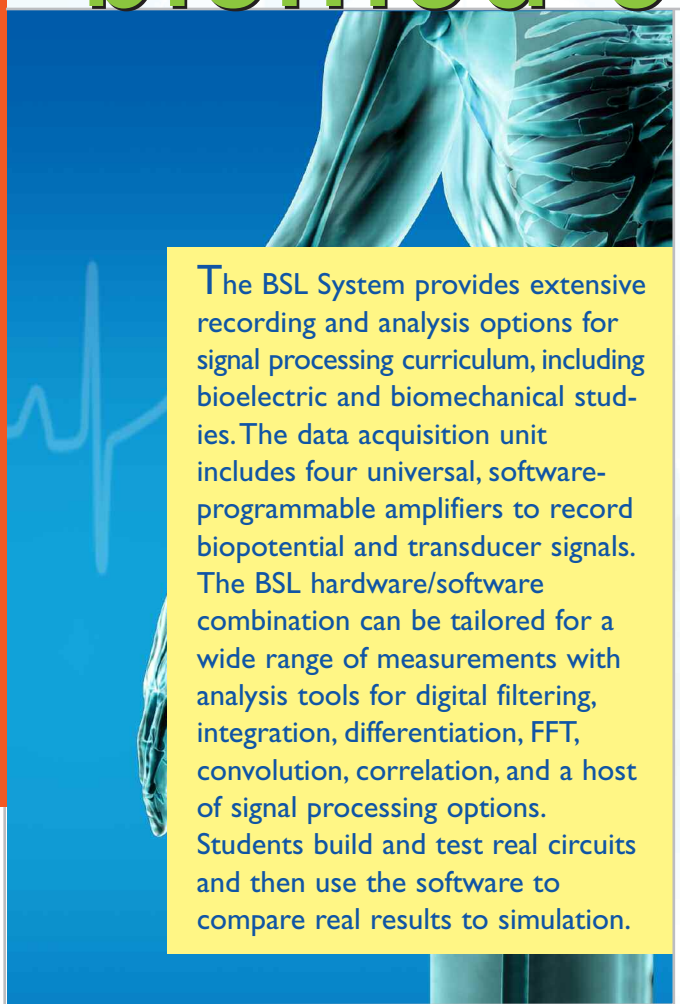
biomed engineering



The BSL System provides extensive recording and analysis options for signal processing curriculum, including bioelectric and biomechanical studies. The data acquisition unit includes four universal, software-programmable amplifiers to record biopotential and transducer signals. The BSL hardware/software combination can be tailored for a wide range of measurements with analysis tools for digital filtering, integration, differentiation, FFT, convolution, correlation, and a host of signal processing options. Students build and test real circuits and then use the software to compare real results to simulation.

features

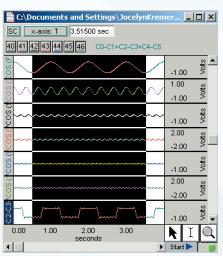
- 60+ lessons targeted for Human & Animal Physiology
- Signal Analysis & Processing
- ECG, EDA (GSR), EEG, EGG, EMG & EOG
- Force, Pressure, Strain, Flow, Temperature, Sound, Light
- Filters (FIR & IIR)
- Instrumentation Design
- Respiratory System & Pulmonary Function
- Bioimpedance (Cardiac Output & Blood Flow)
- Biomechanics—Angle, Acceleration, Distance, Velocity
- Transducers & Calibration
- Physiological Control Systems
- Compartmental Modeling
- Blood Pressure & Heart Sounds
- Gait Analysis
- Chart, Overlap, Scope & X/Y Displays
- Spectral Analysis & Histograms
- Export to MatLab®, LabVIEW®, and MS Excel/Word®

Suitable for inquiry-based, active learning in 2-yr. & 4-yr. programs, medical schools, and nursing programs

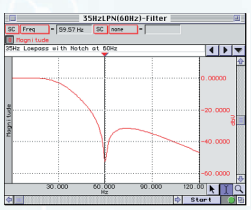
"During each [BIOPAC] laboratory exercise, students follow detailed procedures that are designed to demonstrate principles of biophysics and biological measurement. Student feedback on the laboratories has been phenomenal, with the hands-on experiences motivating the students in a way that no lecture-only course can." *— IEEE Engineering in Medicine and Biology, July/August 2003 (Vol. 22, No. 4, pg. 106)*

Signal Analysis & Processing

The BSL software has an extensive library of signal processing functions permitting graphical insight to analytical methods. The software can demonstrate the procedure and consequences associated with simple to complex signal processing methodologies. For example, students can view data before and after IIR or FIR filter processing, build a complex waveform from periodic signals (i.e., create a square wave from multiple sine waves) and decompose the result, or apply non-linear processing methods to data. Use the X/Y display mode to generate Lissajous patterns and investigate chaotic phenomena and demonstrate phase relationships between two variables. Signals can be correlated and convolved. Use the histogram function to focus on distribution of specific signal measures.



BME Square



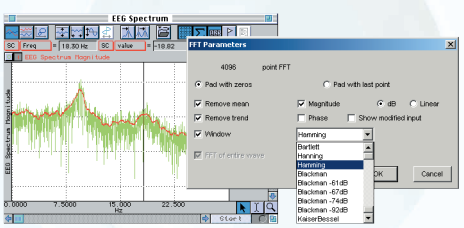
FFT of Biopotential filter frequency response

Transducers & Calibration

The BSL System employs a wide array of transducers that transform physical measures into electrical signals. The generic input design of the MP36 acquisition unit allows it to interface a huge variety of third-party or completely unique transducers. Students can use the BSL software to linearize and calibrate transducers and then compare results to expected values. Relate fundamental physical standards to more complicated measures. For example, calibrate the Airflow Transducer with a syringe, and then use the Airflow Transducer to calibrate a respiration sensor designed to monitor thoracic circumference.

Human & Animal Physiology

The wide range of human and animal physiology experiments provide a powerful tool for teaching students the best technique and methodology for making a measurement. Each experiment demonstrates fundamental physiological concepts and educates students in the setup, recording and analysis process. Physiology basics are clearly explained. See pages 10-13 for details.



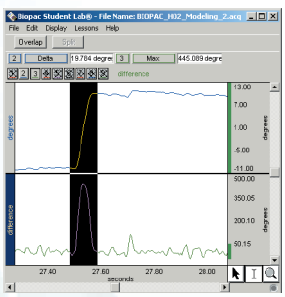
FFT dialog and EEG spectrum

Programming Options

Students can create their own programs to control the MP36 hardware with the BHAPI hardware application program interface. Students can also develop their own analysis programs to read the BIOPAC file format with the ACKAPI software application program interface. See page 24 for details.

Physiological Control Systems & Compartmental Analysis

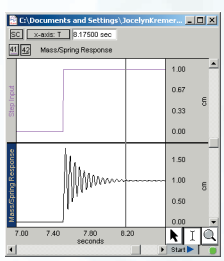
Implement simple experiments illustrating physiological control systems and compartmental analysis with the BSL System. The students can observe signal changes and then effect a change to observe a particular response. Investigate linear and nonlinear control paradigms. Create simple to intricate feedback loops where students perform a specific role in the loop operation. For instance, students can explore Westheimer's saccadic eye movement model which represents the eye as a 2nd order system —then record eye motion via EOG set up, and then compare the real results to the modeled results to validate or adjust the model.



Compartmental Modeling (EOG)

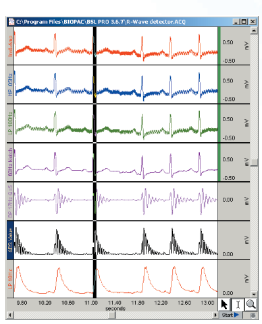
Biomechanics

The Student Lab System has a comprehensive ability to monitor gait and other mechanical responses. The system works with Goniometers, Accelerometers, Heel-Toe Strike transducers and Tri-Axial Accelerometers. Biopotential signals such as EMG can be synchronously recorded. Use the Hand Dynamometer and Tri-Axial Accelerometer to measure isotonic and isometric performance. Goniometers are available for evaluating one or two degrees of freedom from the same joint (e.g. wrist flexion/extension and radial/ulnar deviations). Use the X/Y display mode to monitor motion resulting from two degrees of freedom. Model mechanical systems, demonstrate principles of biomechanical resonance or inertial navigation (acceleration, velocity and position), or convert gravity vectors (from Tri-Axial Accelerometers) into associated "tilt" angles for use in ergonomic evaluations. See page 16 for details.



BME Step

Instrumentation Design



Circuit simulation

The new signal processing breadboard allows students to build and test real-world signal processing circuit modules and then verify their performance against mathematical simulation using graphical comparisons. Students can combine circuit modules, collect physiological signals and then analyze the results. Each circuit module constitutes an important subset of circuit design when recording and processing physiological signals. The BSL system is used like an oscilloscope to make measurements for circuit module evaluation.

Interface with Existing Equipment

The BSL System offers over 60 industry-standard transducers. Further, the BSL System interfaces with other major amplifier and transducer manufacturers encompassing the most commonly used biomedical engineering instruments and sensors by using a wide variety of interface connectors and cables. Choose from 18 ready-made interface connectors, or build your own with the custom interface kit.

biomedical engineering

The following hardware suggestions will enable you to perform a wide variety of applications targeted for **biomedical engineering**. Use BIOPAC lessons or easily create your own experiments with the BSL *PRO* software included with each system. Order the core package or select items à la carte.

See **BSL Hardware** (page 23) for all available transducers, electrodes and accessories.

Biomedical Engineering Core
BSLBME-W (Win) or BSLBME-M (Mac)

Basic BSL System	BSLBSC, p. 8
Airflow Filters (10/pk)	AFT1, p. 34
Airflow Mouthpieces (10/pk)	AFT2, p. 34
Airflow Nose Clips (10/pk)	AFT3, p. 34
Airflow Transducer	SS11LA, p. 27
BP Cuff Transducer	SS19LA, p. 27
Calibration Syringe (600 ml)	AFT6A, p. 34
Electronic Stethoscope Transducer	SS30L, p. 28
Hand Dynamometer	SS25LA, p. 27
Hand Switch	SS10L, p. 26
Headphones	OUT1A, p. 26
Pulse Transducer	SS4LA, p. 26
Signal Processing Breadboard Lab	SS39L, p. 30

Perform 29 or more lessons with this core package:

Muscular

BSL1	Standard & Integrated EMG
BSL2	Motor Unit Recruitment & Fatigue
H07	EMG Contractions—Active Learning
H27	Facial EMG
H34	EGG Electrogastrogram
H36	Muscular Biofeedback

Cardiovascular

BSL5	Components of the ECG (Lead II)
BSL6	Leads I, II, III & Einthoven's Law
BSL7	ECG & Pulse
BSL16	Blood Pressure & Korotkoff Sounds
BSL17	Heart Sounds & Cardiac Events
H08	Dive Reflex—Active Learning
H23	Signal Averaged ECG
H32	Heart Rate Variability

Pulmonary Function

BSL12	Pulmonary Function: Vol. & Capacities
BSL13	Pulmonary Flow Rates: FEV and MVV

Neurophysiology

BSL3	EEG Relaxation & Brain Rhythms
BSL4	Alpha Rhythms in the Occipital Lobe
BSL10	EOG Eye Movement, Saccades & Fixation
BSL11	Reaction Time
H10	EEG & Hemispheric Asymmetry
H12	EOG Saccades & Displacement
H13	EOG Visual Tracking vs. Imagination
H14	Ocular Fixation while reading
H15	Ocular Fixation while viewing an image
H16	Reflexes & Reaction Time - Active Learning

Bioengineering

H02	Compartmental Modeling
H20	BME Filtering
H25	BME Signal Processing (8 modules)
H26	ECG R-wave Detector
H33	FFT Fast Fourier Transformation

See page 42-44 for a description of all available lessons.

Increase your lab options with…

Cardiac Output Sensor	SS31L, p. 29
O_2 & CO_2 Analysis Module	GASSYS2-EA, p. 34
Finger Twitch Transducer	SS61L, p. 30
Heel/Toe Strike Transducer	SS28LA, p. 29
Stimulator	BSLSTMB, p. 25
Tri-Axial Accelerometer	SS26L, p. 29
Transducer Accessory Pack	BSLBME-TA, p. 42