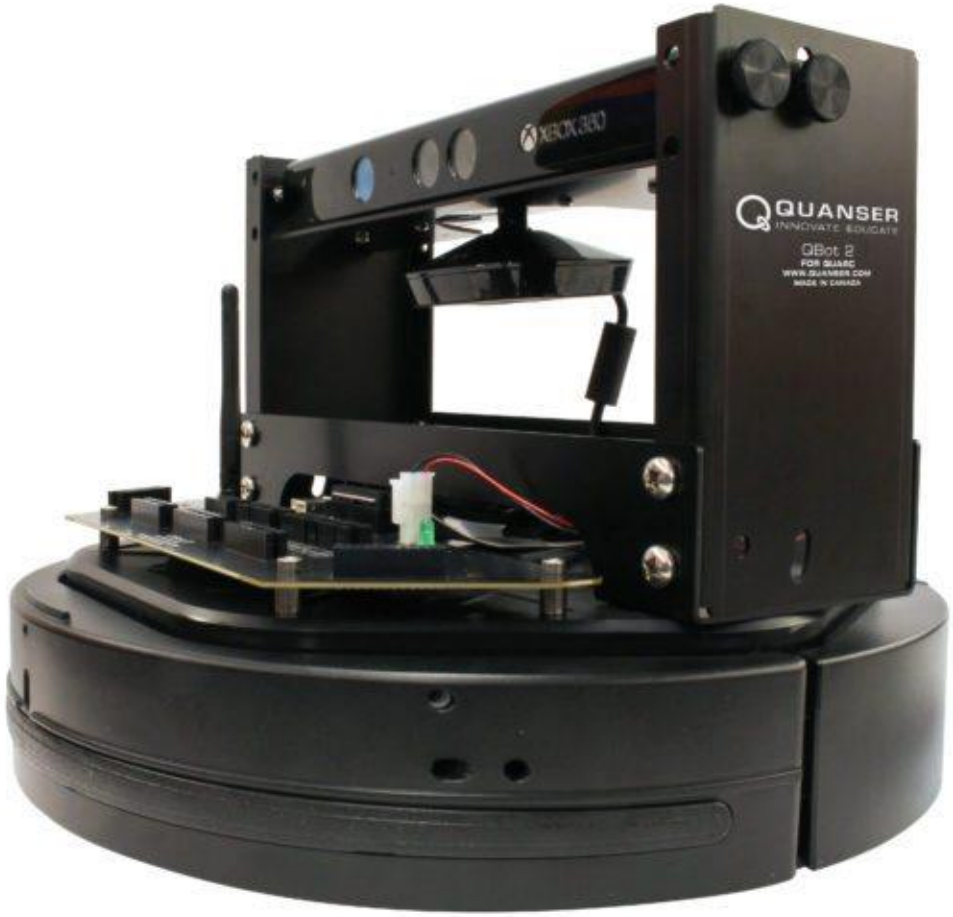
Pictorial View of Lab

1. 2-Degree of freedom Robot MODULE

Concerned Subject	Robotics
Description	The Two Degrees of Freedom (2 DOF) Robot module helps Students learn the fundamentals of robotics. When mounted on two Rotary Servo Base Units (SRV02), you obtain a four-bar link pantograph robot. Students can learn real-world robotic concepts such forward and inverse kinematics, and end effectors planar position control. The 2 DOF Robot module is ideal to introduce students to the fundamental and intermediate principles of robotics. You can use it to demonstrate real-world control challenges, such as pick-and-place robots used in manufacturing lines.
LIST OF EXPERIMENT	Model Topics • Transfer function representation • Kinematics Control Topic • PD(Proportional & Differential)

2. Open architecture autonomous robot (QBOT 2)



Concerned Subject	Robotics
Description	The Quanser QBot 2 for QUARC is an innovative open-architecture autonomous ground robot, equipped with built-in sensors, and a vision system. Accompanied by extensive courseware, the QBot 2 is ideally suited for teaching undergraduate and advanced robotics and mechatronics courses, surpassing capabilities of hobby-level robotic platforms. The open-architecture control structure allows users to add other off-the-shelf sensors and customize the QBot 2 for their research needs.
LIST OF EXPERIMENT	I. Differential drive kinematics II. Forward and inverse kinematics III. Dead reckoning and odometric localization IV. Path planning and obstacle avoidance

V.	2D mapping and occupancy grid map
VI.	Image acquisition, processing and reasoning
VII.	Localization and mapping
VIII.	High level control architecture of mobile robots
IX.	Vision-guided vehicle control

3. DaNI Mobile Robot

Concerned Subject	Robotics
Description	The NI Lab VIEW robotics kit includes DaNI: an assembled robot with frame, wheels, drive train, motors, transducers, computer, and wiring. The hardware can be studied, reverse engineered, and modified by students. However, the major focus of the experiments is robot perception and control fundamentals that are implemented in Lab VIEW software developed on a remote host computer and downloaded to the robot computer. To accomplish this goal, the experiments teach robotics fundamentals and Lab VIEW programming simultaneously.
LIST OF EXPERIMENT	I. Lab view and DaNI II. Ultrasonic Transducer Characterization III. Motor control IV. Kinematics V. Perception with PING VI. Localization

4. Rhino XR-4 Robotic Arm

Concerned Subject	Robotics
Description	The XR-4 is a robotic arm made by Rhino Robotics, Ltd. The XR-4 is a rugged and semi-enclosed five axis robot arm, whose axes are able to move independently and can be controlled simultaneously. It is constructed out of 0.125 inch and 0.250 inch thick aluminum plates and is powered by six PMDC servo motors with integral gearboxes and incremental encoders. The main applications for the XR-4 include education, training, and research.
LIST OF EXPERIMENT	I. Motor Control II. Inverse Kinematics III. Forward Kinematics IV. Remote Controlled Motion

5. Lynx motion AL50 robotic arm (4DOF)

Concerned Subject	Robotics
Description	The AL5D robotic arm delivers fast, accurate, and repeatable movement. The robot features: base rotation, single plane shoulder, elbow, wrist motion, a functional gripper, and optional wrist rotate. The AL5D robotic arm is an affordable system with a time tested rock solid design that will last and last. Everything needed to assemble and operate the robot is included in the kit, with several different software control options.
LIST OF EXPERIMENT	I. Motor control II. Arm control option III. Gripper control option IV. Inverse Kinematics V. Forward Kinematics

6. Lego Mindstroms EVE 3.0

Concerned Subject	Robotics
Description	MINDSTORMS® EV3 gives you the power to create and command your own robotic LEGO creatures, vehicles, machines and inventions! By combining LEGO® elements with a programmable brick, motors and sensors, you can make your creations walk, talk, grab, think, shoot and do almost anything you can imagine.
LIST OF EXPERIMENT	Can create following robots: I. Humanoid Robot II. A Shooting Scorpion III. A Slithering Snake IV. A Fork Lift V. A Race Truck VI. An Electric Guitar VII. A Walking Dinosaur

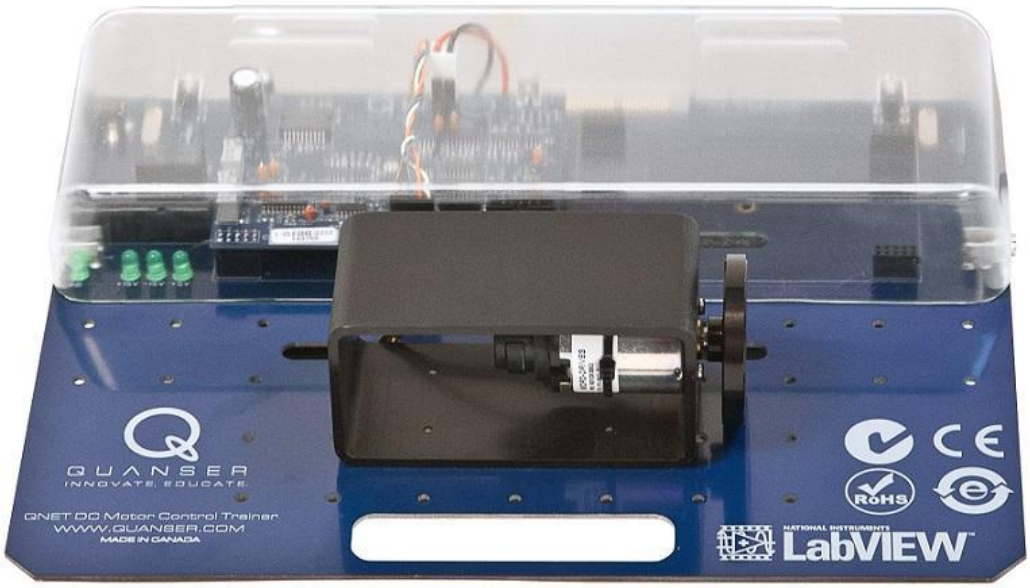
7. NI ELVIS II

Concerned Subject	Control System
Description	The NI Educational Laboratory Virtual Instrumentation Suite (NI ELVIS) II is a modular engineering educational laboratory device developed specifically for academia. With its hands-on approach, educators can help students learn practical, experimental skills. NI ELVIS II features one compact form factor integrated with 12 of the most commonly used instruments in the laboratory. You can connect the PC to these various measurements through USB plug-and-play capabilities and build circuits on a detachable proto-board.
LIST OF EXPERIMENT	I. Oscilloscope II. Bode Analyzer III. Three Wire Voltage-Current Analyzer IV. Counter/Timer V. Analogue Input Circuitry (Multiplexer, A/D to Converters etc.) VI. Impedance Analyzer VII. Digital Multimeter VIII. Function Generator

8. QNET Rotary inverted pendulum

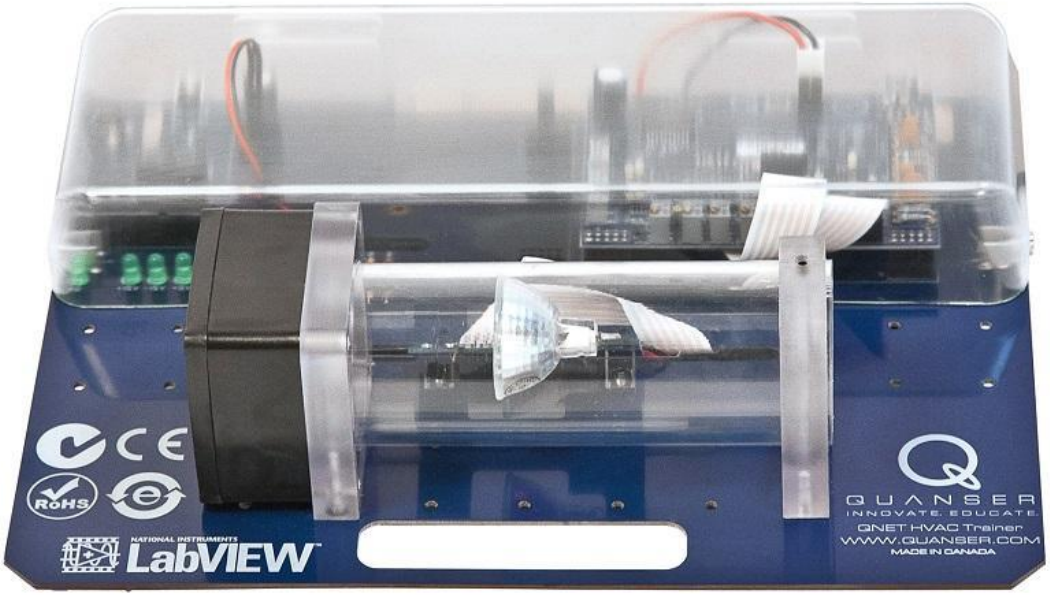
Concerned Subject	Control System
Description	The QNET rotary inverted pendulum trainer has a motor is mounted vertically in a metal Chamber. An L-shaped arm is connected to the motor shaft and pivots between180 degrees. A pendulum is suspended on a horizontal axis at the end of the arm. The pendulum angle is measured by an encoder. The control Variable is the input voltage to the pulse-width modulated amplifier that drives the motor. The output variables are the angle of the pendulum and the angle of the motor.
LIST OF EXPERIMENT	I. Modeling the pendulum II. Balance control (via state-feedback) III. Control optimization (LQR) IV. Friction compensation V. Energy control VI. Hybrid control VII. Multi Variable Control design VIII. System identification

9. QNET DC Motor Control Trainer



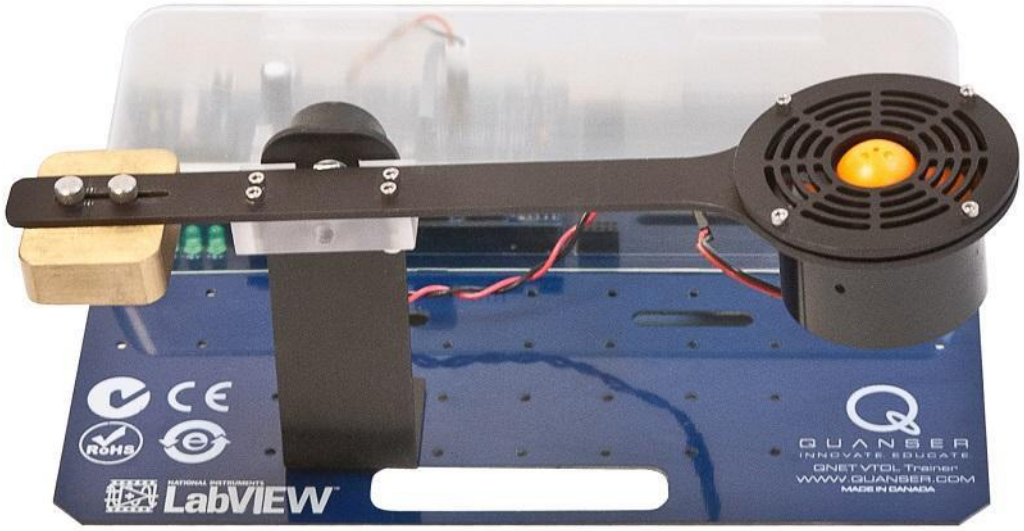
Concerned Subject	Control System
Description	The DC Motor Board illustrates the fundamentals of DC motor control using the NI ELVIS platform and Lab VIEW™ software. It can quickly and easily be configured to control motor position and speed, as well as modeling experiments.
LIST OF EXPERIMENT	I. System modeling II. Model validation III. Position and speed control IV. system simulation V. PID Control design VI. Tracking error VII. Disturbance rejection VIII. Experimental determination the back EMF IX. Experimental model verification X. Experimental modeling using step response

10. QNET HVAC Trainer



Concerned Subject	Control System
Description	The Heating Ventilation and Air Conditioning (HVAC) board teaches students how to design a control system that regulates temperature in a chamber using the NI ELVIS workstation and Lab VIEW™ interface. It is ideal for illustrating concepts covered in fluid dynamics and thermodynamics control courses.
LIST OF EXPERIMENT	I. Temperature control II. Relay/on-off control design III. System modeling IV. Parameter identification V. PI control design VI. HVAC System PWM control VII. System Identification

11. QNET Vertical takeoff and landing trainer



Concerned Subject	Control System
Description	The QNET 2.0 Vertical Take-off and Landing (VTOL) Board is ideally suited to teach and demonstrate the fundamentals of flight dynamics and vertical take-off and landing flight control. Developed exclusively for NI ELVIS platform and Lab VIEW™ software, the system can easily be configured to control the flight of the trainer using a variety of control methods.
LIST OF EXPERIMENT	I. Flight Dynamics II. Experimental Modeling III. PID Control IV. Pitch Control V. Non Linear Friction VI. Root Locus Design VII. Frequency Analysis VIII. Pole-Placement Technique

12. ROTARY SERVO BASE UNIT

Concerned Subject	Control System
Description	The Rotary Servo Base Unit is the fundamental element of the Quanser Rotary Control experiments. It is ideally suited to introduce basic control concepts and theories on an easy-to-use and intuitive platform. Use it on its own to perform several experiments, or expand the scope of this unit by adding on other modules to teach an even wider range of control concepts. Instructors can thus expose students to a variety of rotary control challenges for a minimal investment. Real-world applications of the rotary servomotor include the autofocus feature in modern cameras, cruise control in automobiles, and speed control in CD players.
LIST OF EXPERIMENT	Modeling Topics I. First-principles derivation II. Experimental derivation III. Transfer function representation IV. Frequency response representation V. Model validation Control Topics VI. PID VII. Lead Compensator

13. Coupled Tanks

Concerned Subject	Control System
Description	The Coupled Tanks system consists of a single pump with two tanks. Each tank is instrumented with a pressure sensor to measure the water level. The pump drives the water from the bottom basin up to the top of the system. Depending on how the outflow valves are configured, the water then flows to the top tank, bottom tank, or both. The rate of flow can also be changed using outflow orifices with different diameters. The ability to direct water flow, together with variable outflow orifices allows for several interesting Single Input Single Output (SISO) configurations.
LIST OF EXPERIMENT	I. Derivation of dynamic model from first-principles

II. Transfer function representation
III. Linearization
IV. Level control
V. PID
VI. Feed-forward
VII. Control parameter tuning

14. QUANSER VoltPAQ-X2 Amplifier

Concerned Subject	Robotics and Controls Lab/ Embedded Lab
Description	The VoltPAQ-X2 is linear voltage-controlled amplifier ideal for all complex controls configurations related to educational or research needs. It is designed to achieve high performance with Hardware-In-The-Loop (HIL) implementations.
LIST OF EXPERIMENT	• Voltage and Current amplification • Digital and analogue Signal control

15. NI MYRIO Controller

Concerned Subject	Control System
Description	Provides reconfigurable I/O that allows you to teach and implement multiple design concepts with one device. The myRIO Student Embedded Device features I/O on both sides of the device in the form of MXP and MSP connectors. It includes analog inputs, analog outputs, digital I/O lines, LEDs, a push button, an onboard accelerometer, a Xilinx FPGA, and a dual-core ARM Cortex-A9 processor. Some models also include Wi-Fi support. You can program the myRIO Student Embedded Device with Lab VIEW or C. With its onboard devices, seamless software experience, and library of courseware and tutorials, the myRIO Student Embedded Device provides an affordable tool for students and educators.
Specification	**Processor** Processor type => Xilinx Z-7010 Processor speed=>667 MHz Processor cores=>2 **Memory** Nonvolatile memory=>512 MB

DDR3 memory=>256 MB
DDR3 clock frequency =>533 MHz
DDR3 data bus width=>16 bits

FPGA

FPGA type=>Xilinx Z-7010

USB Ports

USB host port=>USB 2.0 Hi-Speed
USB device port=>USB 2.0 Hi-Speed

Analog Input

Aggregate sample rate=>500 kS/s
Resolution=>12 bits
Overvoltage protection =>.±16 V

Analog Output

Aggregate maximum update rates
All AO channels on MXP connectors =>345 kS/s
Resolution=> 12 bits

Digital I/O

Number of lines
MXP connectors =>2 ports of 16 DIO lines (one port per connector); one UART.RX and one UART.TX line per connector

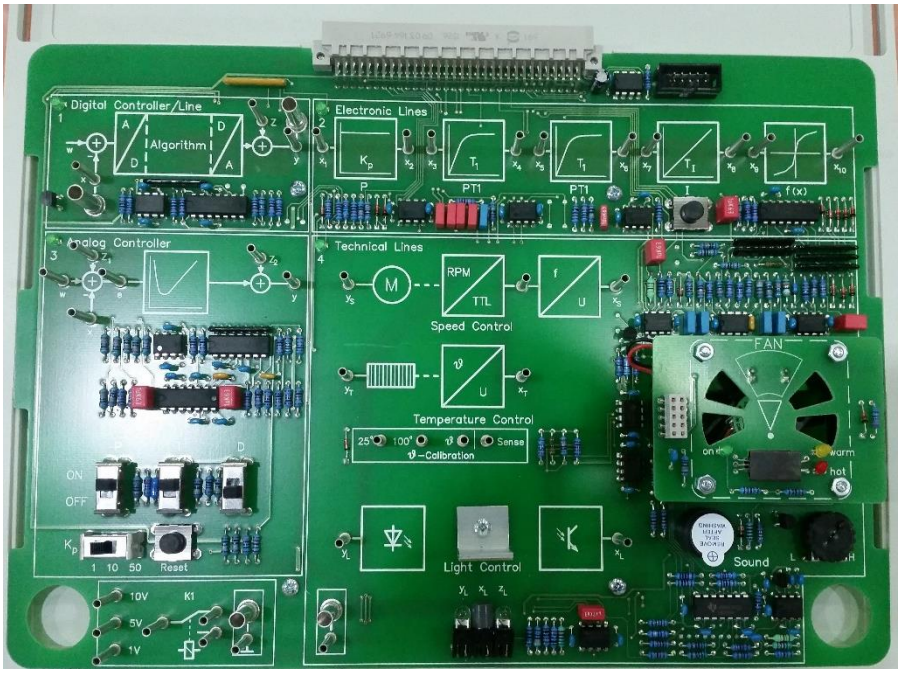
Accelerometer

Number of axes =>3
Range =>±8 g
Resolution=>12 bit

Power Output

+5 V power output
Output voltage => 4.75 V to 5.25 V
Maximum current on each connector => 100 mA

16. Teknitkit Console



Concerned Subject	Control System
Description	Comprises an experiment board, housed within a board carrier, for use in conjunction with, and powered by, the 92-500 Teknitkit Console (supplied separately) teaching a practical course on the fundamentals of automatic control technology, experiments being wired using 2 mm safety cables (14-101 Set of Safety Cables (2 mm), supplied separately). Course content, experiment instructions and tasks are taught via course-specific software).

LIST OF EXPERIMENT	I.	Open-loop control
	II.	Closed-loop control
	III.	Analysis of controlled systems
	IV.	Controlled systems with/without compensation
	V.	Controlled systems of a higher order
	VI.	Types of controllers
	VII.	P, I, PI, PID and PD control
	VIII.	Automatic digital control
	IX.	Performance criteria for automatic controls
	X.	Optimization guidelines for PID controllers
	XI.	Automatic temperature control
	XII.	Automatic speed control
	XIII.	Automatic light control
	XIV.	Automatic control of systems without compensation
	XV.	Automatic control with discontinuous controllers
	XVI.	Fault simulation

17. QNET Mechatronics Actuator Board

Concerned Subject	Sensor, actuator and instrumentation
Description	One of the topics covered in a typical introductory mechatronics course is understanding and application of actuators commonly used in modern mechatronic systems. The QNET Mechatronic Actuators board is an ideal tool to introduce hands-on a variety of actuators, and demonstrate their advantages, interfacing and operation, as well as design considerations and limitations. Designed exclusively for NI ELVIS platform and Lab VIEW™ software, students learn principles of electromagnetic actuation, linear and PWM actuators, brushed and brushless DC motors, stepper motors and servos.
LIST OF EXPERIMENT	I. Principles of electromagnetic actuation ○ Magnetic fields of coiled conductors ○ Implementation of electromagnetic field theory in solenoids II. Principles of linear and pulse width modulation (PWM) amplifiers ○ Actuator dead-band measurement and compensation ○ Linearity of an amplifier III. Principles of brushed and brushless DC motors IV. Principles of stepper motors, their control and excitation modes V. Introduction to servo motor position control

18. KL-620 Basic Sensor Experimental Lab

Concerned Subject	**Sensor, actuator and instrumentation**
Description	The KL-620 Basic Sensor Experimental Lab is a comprehensive sensor / transducer control training system. Its modular and closed-loop control circuits allow implementation of open-ended, individual control loops used in industrial applications. KL-620 provides qualitative experiments, it uses different sensors or transducers for experiments. With KL-620, we give attention to observe the relationship between analog signals (like temperature or pressure) and voltage. The analog signals (like temperature or pressure) cannot be measured and represented by a value. The KL-620 uses only industrial-standard sensors / transducers (0~10V, 4~20mA) with USB interface.
LIST OF EXPERIMENT	I. D/A and A/D Converters II. Characteristics of Sensors III. Gas Sensors IV. AD590 Temperature Transducer

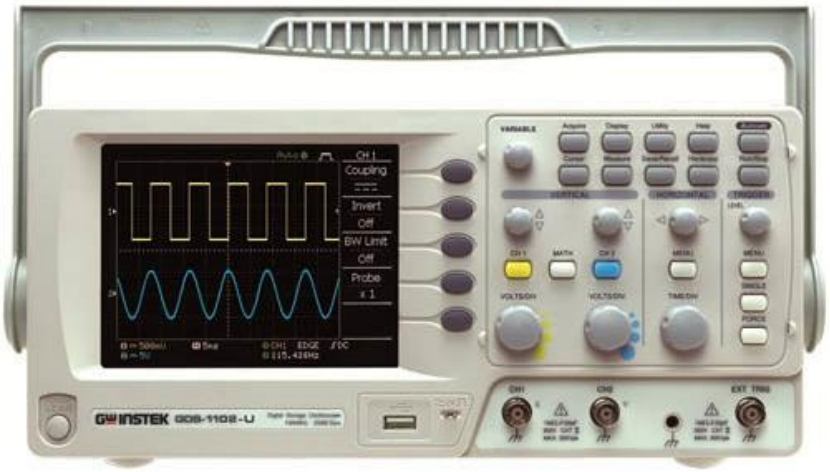
V.	Hall Current Sensor
VI.	PT100 Temperature Sensor
VII.	Humidity Sensor
VIII.	Strain Gauge
IX.	Linear Variable Difference Transformer (LVDT)
X.	Photovoltaic Cell
XI.	Proximity Switch
XII.	Infrared Transducer
XIII.	Ultrasonic Transducer
XIV.	Pressure Sensor
XV.	V/F and F/V Converters
XVI.	CDS Cell
XVII.	Level Controller
XVIII.	Fiber Optical Communication
XIX.	Rotation Angle Sensor

19. DUAL CHANNEL ARBITRARY FUNCTION GENERATOR

Concerned Subject	Sensor, actuator and instrumentation
Description	AFG-2225 is first basic level dual-channel arbitrary function generator, which provides superior features in its class. Both channels are equipped with same characteristics to fit dual-signal applications such as differential or IQ signaling. The outstanding cost-performance value makes the AFG-2225 a practical instrument to accelerate the development process.
Specification	1. Wide Frequency Ranges From 1µHz to 25MHz (sine/square wave) 2. 1 µHz Resolution in Full Range 3. Built-in Standard 120MSa/s, 10bit, 4k Points Arbitrary Waveform for Both Channels 4. True Dual-Channel Output, CH2 Provides the Same Characteristics as CH1 5. Couple, Tracking, Phase Operations of Dual Channel are Supported

	6. 1% ~ 99% Adjustable Duty Cycle for Square Waveform 7. High Resolution and Colored TFT LCD with Friendly User Interface 8. Multiple Editing methods to Edit Arbitrary Waveform Easily 9. Built-in Standard AM/FM/PM/FSK/SUM/Sweep/Burst and Frequency Counter 10. USB Host/Device Interface for Remote Control and Waveform Editing

20. DIGITAL STORAGE OSCILLOSCOPE GDS-1072-U:



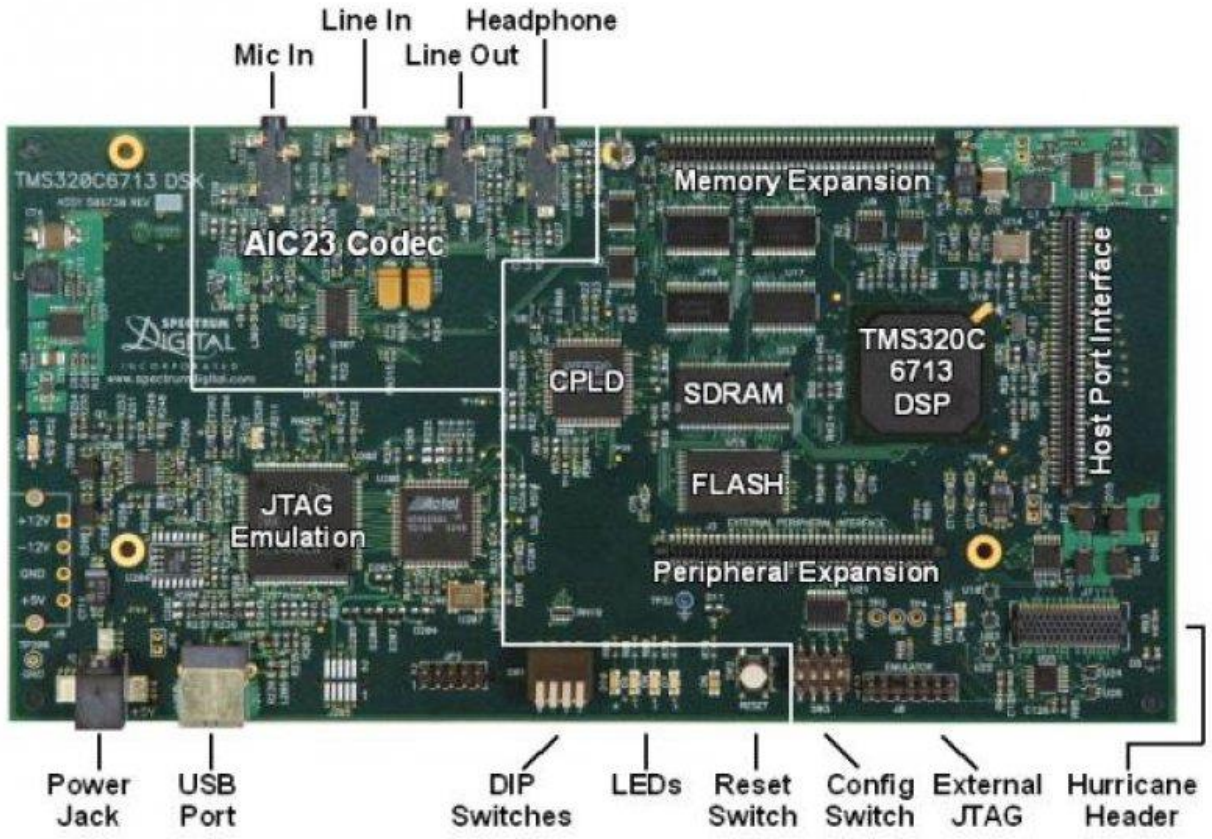
Concerned Subject	Sensor, actuator and instrumentation
Description	A mixed-signal oscilloscope has two or four analog channels and a larger number of digital channels (typically sixteen). It provides the ability to accurately time-correlate analog and digital channels, thus offering a distinct advantage over a separate oscilloscope and logic analyzer.
Specification	I. 70MHz bandwidth selections II. 4 channels III. Equipped with a 16-channel logic analyzer and a dual channel 25MHz arbitrary waveform generator IV. Maximum real time sample rate is 1 GSa/s V. Maximum 10M memory depth and VPO waveform display technology VI. Waveform update rate up to 120,000 wfms/s VII. 8” WVGA TFT LCD screen display

VIII.	Maximum 1M FFT provides higher frequency domain resolution measurements
IX.	High pass and low pass filter functions

21. SPECTRUM ANALYZER GSP-730:

Concerned Subject	Sensor, actuator and instrumentation
Description	GW Instek GSP-730 is a 3 GHz Spectrum Analyzer mainly developed to fulfill the demands of RF Communication educations. Budget constraint and insufficient teaching tools are normally the two hurdles for schools to provide high-quality courses for RF communication experiments
Specification	I. Frequency Range : 150kHz ~ 3GHz II. Autoset Function III. Noise Floor: ≦-100dBm IV. RBW Range : 30kHz, 100kHz, 300kHz, 1MHz V. ACPR/CHPW/OCBW Measurement VI. 3 Traces in Different Colors VII. Split Window Function VIII. Presentation Material for Training Courses IX. Support Interface : USB Device/Host, RS-232C

21. DSP starter kit TMC 320c6713B



CONCERNED Subject	Digital Signal Processing
Description	The TMS320C6713 DSP Starter Kit (DSK) developed jointly with Spectrum Digital is a low-cost development platform designed to speed the development of high precision applications based on TI´s TMS320C6000 floating point DSP generation. The kit uses USB communications for true plug-and-play functionality. Both experienced and novice designers can get started immediately with innovative product designs with the DSK´s full featured Code Composer Studio™ IDE and eXpress DSP™ Software which includes DSP/BIOS and Reference Frameworks
Specification	I. Embedded JTAG support via USB II. High-quality 24-bit stereo codec III. Four 3.5mm audio jacks for microphone, line in, speaker and line out IV. 512K words of Flash and 16 MB SDRAM V. Expansion port connector for plug-in modules VI. On-board standard IEEE JTAG interface VII. +5V universal power supply

22. DSP starter kit TMS320C6416 (1 GHZ)

Concerned Subject	Digital Signal Processing
Description	The TMS320C6416 DSP Starter Kit (DSK) developed jointly with Spectrum Digital is a low-cost development platform designed to speed the development of high performance applications based on TI´s TMS320C64x DSP generation. The kit uses USB communications for true plug-and-play functionality. Both experienced and novice designers can get started immediately with innovative product designs with the DSK´s full featured Code Composer Studio™ IDE and eXpressDSP™ Software which includes DSP/BIOS and Reference Frameworks.
Specification	I. Embedded JTAG support via USB II. High-quality 24-bit stereo codec III. Four 3.5mm audio jacks for microphone, line in, speaker and line out IV. 512K words of Flash and 16 MB SDRAM V. Expansion port connector for plug-in modules VI. On-board standard IEEE JTAG interface VII. +5V universal power supply