WADHWANI FOUNDATION

Wadhwani Electronics Lab

Since 2001
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# WEL Summer workshop 2021

**A two-week summer school on**

## Digital System Design and Verification using CPLD

**and**

## Microcontroller Lab based on Pt-51

**Organized by,**

**Wadhwani Electronics Lab, Dept of Elect Engg, IIT Bombay**

**in association with,**

NPTEL

**June 28, 2021 to July 10, 2021**

**Course instructor: Prof D. K. Sharma**

**Course coordinator: Prof Siddharth Tallur**

## Preamble:

**Covid-19 has impacted all segments of society including the education sector. It has forced us to adopt new technology for teaching and to explore new alternatives to face-to-face education and the laboratory courses which are a quintessential part of engineering education. Most of the institutes have arranged theory lectures on various online platforms but conducting laboratory courses has been a challenge. Simulation based laboratory courses have been adopted by many as today there do not seem to be any other option. However, that can not be the long term solution for engineering lab courses.**

**We, at Wadhwani electronics Lab, IIT Bombay, have successfully completed two online lab courses for a class of 160-300 undergraduate students of EE Department, IIT Bombay, without compromising the course content.**

**We would like to make these courses available for the students beyond IIT Bombay through a two week WEL Summer workshop-2021 during 28 June to 10 July, when the students would have completed their academic year 20-21. Both the courses are very comprehensive and will be run during the same period. So the students are requested to apply for only one course.**

# Digital System Design and verification using CPLD

## Overview:

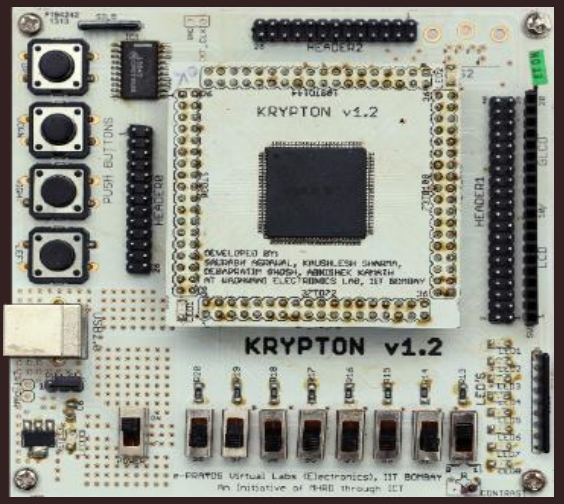
The development of CPLDs and FPGAs has dramatically changed the methodology of prototyping of digital hardware and are becoming the essential platforms for high performance systems. This forces us to teach digital system design using FPGAs at an undergraduate level. Wadhwani Electronics Lab has developed a low-cost solution through Krypton, a CPLD board developed in-house.

The proposed course is expected to provide foundation for FPGA based design with hands-on skills with supporting lectures and tutorials. Students will learn digital design, VHDL, use of Quartus and ModelSim, the software tools, and verify the designs implemented on the CPLD using scan chain technique. The course is suitable for third year UG students and in general, Hardware Electronics Design career track aspirants.

## Proposed Lab experiments:

- Tutorials on Quartus-II, generalized test bench, CPLD board and Scan Chain verification
- Structural modelling of combinational digital circuits, implementation and verification of the design
- Behavioral modelling of combinational digital circuits, implementation and verification of the design
- Design, implementation and verification of Finite State Machines using structural modelling
- Design, implementation and verification of Finite State Machines using behavioral modelling

## Krypton: The CPLD board developed by WEL




Krypton Board

## Specifications of Krypton:

- Based on Intel's MaxV 5M1270: 1270 Logic elements
- On-board clock of 1 Hz / 50MHz
- provision for external clock
- on-board 8 inputs (switches), 8 outputs (LEDs), and 4 push buttons with hardware debounce
- 96 I/O lines
- USB programmable and powered
- On-board connectors for interfacing standard peripherals (LCD)
- On-board scan chain environment for verification of the design

## Who should register:

**The third year students from the NPTEL's SPOC with sound knowledge of:**

- **Digital Electronics, Programming in C or Python (mandatory)**
- **Basic knowledge of VHDL ( preferred)**

## Certification:

- **e-certificates will be issued to successful participants. The grades will be awarded based on the two exams conducted at the end of each week.**
- **The students with excellent performance get a free FPGA board for their B.Tech projects in addition to an opportunity to carry out an internship at WEL.**

## Workshop fees:

- **Kit price: Rs. 5000/- (75% amount refundable on returning after successful completion)**
- **Registration deposit: Rs. 800/- (Fully refundable after completion of workshop)**
- **Exam fees : Rs. 200/- non-refundable**
- **Total payable at the time of registration: Rs. 6000/-**

**The students will be shipped the workshop kits after the payment of Rs. 6000/- as mentioned above. The Course completion certificate will be awarded after successful completion of course and returning the workshop kit. Candidates who are eligible for certificates will get back 75% of kit price and workshop registration deposit.**

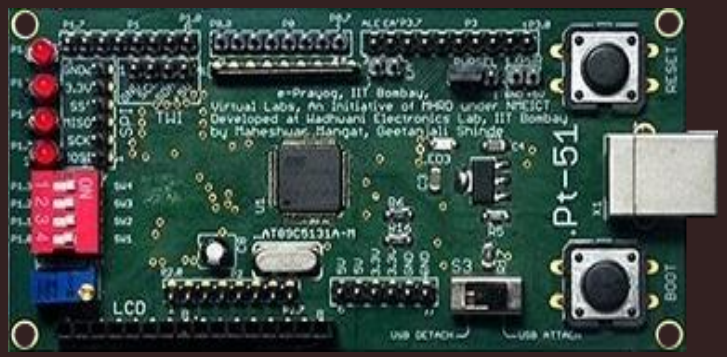
## Last Day for registration: 31st May 2021

# Microcontroller Lab based on Pt-51

## Overview:

Pt-51 is the microcontroller board designed and developed at Wadhwani Electronics Lab for teaching Microcontroller and embedded system lab courses. Intel's MCS51 is the most popular choice in academia as the basic microcontroller to teach. MCS51 and its variants are still being used in industry. Atmel's, now Microchip's AT89CS131 microcontroller has been chosen as it is an advanced version of the 8052 core with USB programmability.

The board is used to teach the microcontroller architectural concepts, assembly level programming, interfacing peripherals, communication protocols, embedded C programming, etc.




Pt-51 Board

## Specifications of Pt-51:

- AT89C5131 MCU with on-chip 32KB program memory
- USB powered and USB in-system programmable
- Dedicated interfaces for standard communication protocols such as UART, SPI, TWI
- On-board 24 MHz clock and regulated supplies of 3.3V and 5V
- Four onboard DIP switches and LEDs for quick testing and simple programs
- An onboard slot for 16×2 character LCD
- 32 general-purpose I/O(GPIO) lines available for custom use

## Highlights of Pt-51 based lab:

- Comprehensive lectures on architecture of MCS51, instruction set, Timers, interrupts, serial communication, SPI,I2C protocol.
- Tutorials on Keil $\mu$Vision IDE, Microchip's FLIP for ISP, using Pt-51
- Set of Experiments:
  - Simple assembly level programming
  - LCD interfacing
  - Reaction timer
  - Interfacing UART module
  - Interfacing SPI ADC
  - A mini project

## Who should register:

The third year students from the NPTEL's SPOC with sound knowledge of:

- Digital Electronics, Programming in Assembly and embedded-C (mandatory)
- Basic knowledge of microcontroller (preferred).

## Workshop fees and certification:

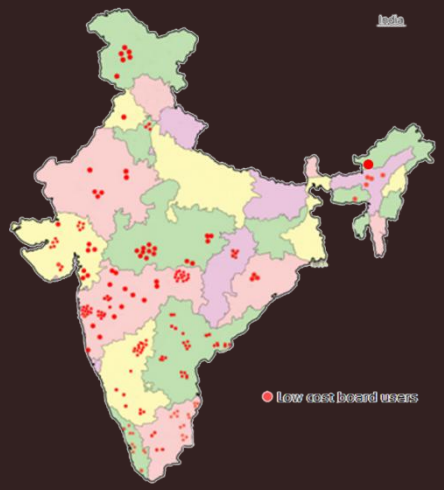
- Total fees payable at the time of registration- Rs.3000 including:
  - Kit: Rs. 2000/- (75% amount refundable on returning after successful completion)
  - Registration deposit: Rs. 800/- (fully refundable)
  - Exam fees: Rs. 200/- (non-refundable)
- The students will be shipped the workshop kits after the payment of Rs. 3000/- as mentioned above.
- e-certificates will be issued to successful participants. The grades will be awarded based on the two exams conducted at the end of each week.
- The students with excellent performance will get a free Pt-51 board for their B.Tech projects in addition to an opportunity to carry out an internship at WEL.

## Last Day for registration: 31st May 2021

## About WEL:

The Wadhwani Electronics Lab (WEL) in the Department of Electrical Engineering at IIT Bombay, has been set up as a consequence of an endowment from Padmashri Dr. Romesh Wadhwani (batch of 1969) since 2001.

WEL caters to several lab courses for undergraduate and post-graduate students in the department. We, at WEL, have developed several low-cost portable kits which are USB powered and programmable. One can perform the experiments without any lab equipment other than a computer, few electronic components and a breadboard. WEL has conducted more than 20 workshops at various engineering colleges across India in the last decade, and trained more than 2,000 teachers to use the hardware and lab content developed in WEL.

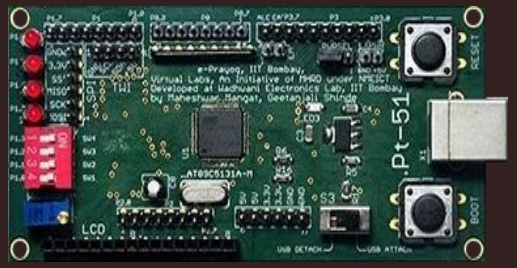



User outreach across India

## Boards developed at WEL for various courses:

Various boards have been developed and deployed for following lab courses at IIT Bombay and outreach activities of WEL.

- Digital System design
- Microcontrollers
- Communication systems
- Electronics Design Laboratory
- Embedded Design Lab



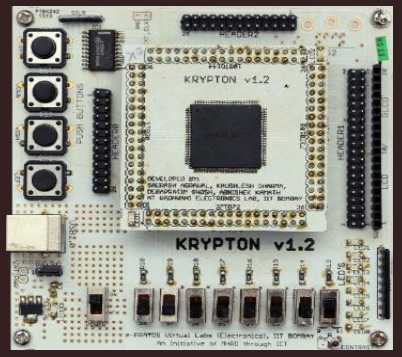

PT-51 (AT89C5131 based)


AURUM (PIC-18F4550 based)

MICROCONTROLLER BOARDS (Since 2012)

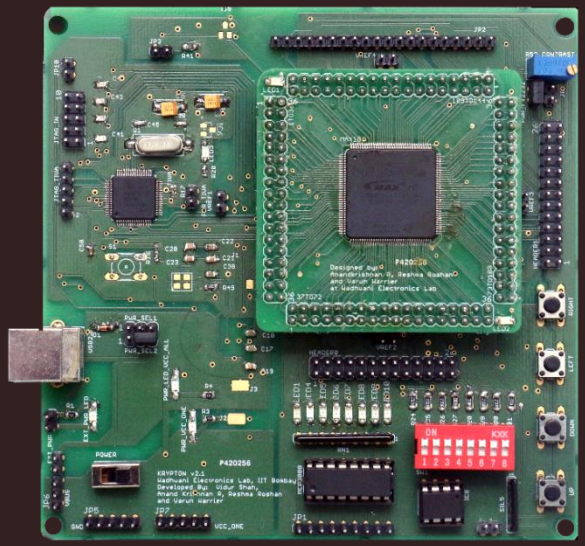
IQ MODULATOR Board for Communication Lab (Since 2014)


**HELIUM (Altera MAX3000 CPLD)**
**(Since 2009)**




**KRYPTON (Intel MAX based)**
**(since 2012)**


**All-in-one portable Lab**
**(for device characterizatio and analog circuits, comprising of Function generator, DSO and automated characterization) [Ready for deployment]**




**XENON FPGA: Based on Intel MAX10 FPGA (10M25SAE144C8G with 24,960 LEs)**
**(Ready for deployment)**