DIGITAL ELECTRONIC CIRCUITS

PROF. GOUTAM SAHA

Department of Electronics
& Communication Engineering
IIT Kharagpur

PRE-REQUISITES : Basic understanding of diode, transistor operation. If this is not covered in 10+2 Board of the students then the same may be studied from Basic Electronics or Analog Electronic Circuits course.
INTENDED AUDIENCE : Electronics, Electrical, Instrumentation, Computer Science

COURSE OUTLINE :
There is a notable increase in the use of the word 'digital' for products and services that are becoming part of our everyday life. Examples are digital camera, digital watch, digital weighing machine, digital signature, digital payment, digital art and so on. The digital prefix associates a term with digital technology and is considered a step up in the delivered performance at a given cost. The world of digital provides easy storage and reproduction, immunity to noise and interference, flexibility in processing, different transmission options, and very importantly, inexpensive building blocks in the form of integrated circuits. Digital systems represent and manipulate digital signals. Such signals represent only finite number of discreet values. A signal can be discreet by nature whereas, a continuous signal can be discretized for digital processing and then converted back. Manipulation and storage of digital signal involves switching. This switching is done through electronic circuits. Basic gates made from electronic circuits are primary building blocks of digital systems. These gates combine in different ways to develop digital circuits that are associated with different functionalities. This is helped by an understanding of Boolean Algebra. The functional blocks in turn, combine to generate a complex digital system. There are general purpose programmable blocks, too. This course is aimed at developing a deep understanding of digital electronic circuits. At the end of the course, one would be able to analyze and synthesize different kind of combinatorial and sequential digital systems for real-world use.

ABOUT INSTRUCTOR :
Prof. Goutam Saha, BTech, PhD from IIT Kharagpur had a short Management Training at XLRI, Jamshedpur. During 1990-1994, he worked with Tata Steel. He joined as faculty member in the Dept. of Electronics and Electrical Communication Engineering at IIT Kharagpur in 2002. In 2006 fall semester, he served University of Southern California, USA. His research interest includes biomedical and speech signal processing with collaborations from India and abroad. His work was declared a winner in DST-Lockheed Martin India Innovation Growth Program, selected for Rashtrapati Bhavan exhibition, became editorial article of peer reviewed research journal, features in India Innovates Youtube channel and was also covered in leading media. He has published papers in leading international journals and conference proceedings, filed several patents and co-authored two popular textbooks published by McGraw-Hill Education. He has a decade long experience of teaching the 'Digital Electronic Circuits' course to IIT Kharagpur undergraduates.

COURSE PLAN :

Week 1 : Introduction; Relation between switching and logic operation; Use of Diode and Transistor as switch; Concept of noise margin, fanout, propagation delay; TTL, Schottky TTL, Tristate; CMOS Logic, Interfacing TTL with CMOS
Week 2 : Basic logic gates, Universality of NAND, NOR gates, AND-OR-Invert gates, Positive and Negative Logic; Boolean Algebra axioms and basic theorems; Standard and canonical representations of logic functions, Conversion between SOP and POS; Simplification of logic functions, Karnaugh Map, Don't Care Conditions
Week 3 : Minimization using Entered Variable Map, Minimization using QM algorithm; Cost criteria, Minimization of multiple output functions; Static-0, Static-1 and Dynamic Hazards and their cover.
Week 4 : Multiplexer; Demultiplexer / Decoder, BCD to 7-segment decoder driver; Encoder, Priority encoder; Parity generator and checker
Week 5 : Number systems-binary, Signed binary, Octal, hexadecimal number; Binary arithmetic, One's and two's complements arithmetic; Codes, Code converters; Adder, Subtractor, BCD arithmetic
Week 6 : Carry look ahead adder; Magnitude comparator; ALU; Error detecting and correcting codes
Week 7 : Bistable latch, SR, D, JK, T Flip-Flop: level triggered, edge triggered, master – slave, Various representations of flip-flops; Analysis and synthesis of circuits that use flip-flop
Week 8 : Register, Shift register, Universal shift register; Application of shift register: ring counter, Johnson counter, sequence generator and detector, serial adder; Linear feedback shift register
Week 9 : Up and down counter, Ripple (asynchronous) counters, Synchronous counters; Counter design using flip flops, Counter design with asynchronous reset or preset; Applications of counters
Week 10 : Design of synchronous sequential circuit using Mealy model and Moore model: state transition diagram, algorithm state machine (ASM) chart; State reduction technique
Week 11 : Digital to analog converters: weighted resistor/converter, binary ladder, converter, accuracy and resolution; Analog to digital converter: quantization and encoding, different types of conversion, accuracy and resolution
Week 12 : Memory organization and operation, Memory expansion; Memory cell; Different types of memory, ROM, PROM, PAL, PLA, CPLD, FPGA