EE3C02  DIGITAL CIRCUITS [5 credits]

Lecturer(s):  Dr. M. J. Burke  mburke@tcd.ie

Module organisation

Semester 1:  3 Lectures and 1 Tutorial per week. Two associated Laboratories

Module description, aims and contribution to programme
Digital Circuits is a one semester module taken by Junior Sophister C, CD and D Stream students. It provides a thorough foundation in digital circuits as applied to modern logic device families. The module aims to provide students with knowledge of the operational principles and practical limitations of digital circuits at device and circuit level, as well as instructing them in the analysis and design of these circuits. All of the principles and techniques learned are applicable to the design of digital circuits on a wider scale. During the module, students will develop the analytical and synthesis skills needed to design digital circuits for electronic equipment intended for any modern application area. In particular C Stream Electronic Engineering students will use these skills later in further circuit and system design modules, while CD Stream Electronic & Computer Engineering and D Stream Computer Engineering students gain the insight needed to appreciate how the design of digital circuits influences and ultimately limits the performance of computers at gate, architectural and system level. The issues encountered ultimately influence factors such as critical paths, throughput rates, instruction cycle times, signal integrity, and data loss which are most important issues in modern computers.

Learning outcomes
On completion of this module the student should be able to:
   1. Explain the operation of the bipolar junction and MOS Field Effect Transistors and associated logic gates.
   2. Analyse simple single-transistor switching circuits to determine their performance criteria and limitations.
   3. Analyse simple single-transistor switching circuits to determine static and dynamic performance parameters and related figures of merit.
   4. Explain the operation and evaluate the performance of fundamental TTL and CMOS logic gates.
   5. Design simple transistor circuits for practical discrete applications from a performance specification.
   6. Carry out circuit analysis experiments using CAD tools such as MultiSim in a systematic and disciplined manner.

Module content
- Semiconductor Electronics: fundamental semiconductor laws; carrier transport phenomena; current flow mechanisms.
• Bipolar Junction Diode: the p-n junction; barrier potential; the ideal diode equation.

• Bipolar Junction Transistor: physical principles of operation; device characteristics and parameters.

• Bipolar Transistor Inverter: operation of the BJT transistor as a switch; simple inverter circuit; static and dynamic performance characteristics; effects of loading.

• BJT Inverter Applications: the design of simple bipolar transistor circuits to act as buffers, drivers and interfaces in a range of applications.

• TTL Logic Family: logic characteristics and performance; operating principles of standard 7400 series gates; circuit analysis and power consumption evaluation, Advanced TTL families.

• MOS Field Effect Transistor: physical principles of operation; device characteristics and parameters.

Teaching strategies
The module is taught using a combination of lectures, tutorials and two supporting laboratories. During the tutorials students will develop their problem solving skills by tackling problems based on the lecture material.

Assessment
The module will be assessed by a two-hour written examination and continuous assessment based on laboratory reports. The written examination will contribute 85% and the laboratories will contribute 15% of the overall subject mark at the Annual Examinations.
The overall subject mark at the Supplemental Examinations will be determined solely on the basis of the written examination.

Required textbook


Further information
http://www.tcd.ie/Engineering/undergraduate/baiyear3/