### Module Title: Digital Circuits  
**Code:** EE3C02

<table>
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<tr>
<th>Level: Junior Sophister</th>
<th>Credits: 5</th>
<th>Prerequisites: SF Year</th>
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<tr>
<td><strong>Lecturer(s):</strong> Associate Professor Dr. M. J. Burke</td>
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<tr>
<th>Terms: Semester 1</th>
<th>Lectures/week: 3</th>
<th>Tutorials/week: 1</th>
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<tr>
<td><strong>Duration (weeks):</strong> 12</td>
<td><strong>Total:</strong> 33</td>
<td><strong>Total:</strong> 11</td>
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### Aims/Objectives
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 integrated circuit 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.

### Syllabus
- 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.
- MOS Transistor Inverter: operation of the MOS transistor as switch; simple inverter circuit; static and dynamic performance characteristics; effects of loading.

- CMOS Logic family: the principles of operation of simple CMOS logic gates.

### ASSOCIATED LABORATORY/PROJECT PROGRAMME

**Lab D1:** Bipolar Junction Transistor: assessment of bipolar transistor inverter operation.

**Lab D2:** MOSFET Transistor: assessment of MOS transistor inverter operation.

**Note:** Properly structured laboratory reports must be written up after each laboratory and submitted for marking.

### RECOMMENDED TEXT(S)


### 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. Analyze simple single-transistor switching circuits to determine their performance criteria and limitations.

3. Analyze 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.

### 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 MODE(S)

The two-hour 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.