Unit 71: Combinational and Sequential Logic

Unit code: K/601/1362
QCF level: 4
Credit value: 15

- **Aim**

This unit aims to provide learners with the skills and understanding required to design and build electronic circuits that use combinational and sequential logic.

- **Unit abstract**

This unit will develop learners’ understanding of digital techniques and the practical applications of both combinational and sequential logic.

Learners will investigate the characteristics and applications of combinational and sequential logic devices. They will then design, construct and test combinational and sequential circuits and will use relevant computer software to simulate and verify circuits.

Learners will then go on to design a digital system that meets a specification and will evaluate the design against given criteria. They will investigate the minimisation of digital circuits and will improve the digital system design through the use of programmable logic devices (PLDs).

- **Learning outcomes**

On successful completion of this unit a learner will:

1. Be able to design and build circuits using combinational logic
2. Be able to design and build circuits using sequential logic
3. Be able to design and evaluate a digital system.
Unit content

1 **Be able to design and build circuits using combinational logic**

*Manufacturers’ data sheets:* printed; CD ROM; websites

*Devices:* buffer; line driver; decoder; multiplexer; programmable read-only memory (PROM); programmable logic devices

*Characteristics:* device technology eg transistor-transistor logic (TTL), complementary metal-oxide–semiconductor (CMOS); function; fan-out; propagation delay; power consumption; cost; size; packaging; operating voltage; availability

*Computer simulations:* using a commercial digital electronic circuit analysis package

2 **Be able to design and build circuits using sequential logic**

*Sequential logic devices:* J-K flip-flop; D-type flip-flop; monostable; counter; parallel latch; shift register

*Design sequential circuits:* minimisation; race hazards; clock speeds; power supply decoupling; clock speed/power trade-off for CMOS

*Sequential logic circuits:* clock generator; BCD counter; parallel to serial converter; pseudo random number generator

*Computer simulation:* using a commercial digital electronic circuit analysis package

3 **Be able to design and evaluate a digital system**

*Digital system design:* systems with both combinational and sequential devices; up to 20 components; possibly including programmable devices

*Evaluation criteria:* functionality; chip count; cost

*Reduce chip count:* by replacing logic devices with programmable devices eg erasable programmable logic devices (EPLD), Generic Array Logic (GAL) devices, Programmable Array Logic (PAL) devices, programmable read-only memory (PROM)
## Learning outcomes and assessment criteria

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<th>Learning outcomes</th>
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<td><strong>On successful completion of this unit a learner will:</strong></td>
<td><strong>The learner can:</strong></td>
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| LO1 Be able to design and build circuits using combinational logic | 1.1 interpret manufacturers’ data sheets to select appropriate combinational logic devices for specific purposes  
1.2 compare the characteristics of similar devices using different technologies  
1.3 design, construct and test combinational circuits  
1.4 use computer software packages to simulate logic circuits |
| LO2 Be able to design and build circuits using sequential logic | 2.1 describe the operation of sequential logic devices  
2.2 use formal design techniques to design sequential circuits  
2.3 construct and test sequential circuits  
2.4 use computer simulation to verify logic designs |
| LO3 Be able to design and evaluate a digital system | 3.1 design a digital system to meet a technical specification  
3.2 realise, test and evaluate the design against criteria  
3.3 improve the design by reducing the chip count through the use of programmable logic devices. |
Guidance

Links
This unit may be linked with Unit 66: Electrical, Electronic and Digital Principles.

Essential requirements
Centres need to provide access to manufacturers’ data sheets and computer circuit analysis packages for circuit simulation.

Employer engagement and vocational contexts
Delivery would benefit from visits to local engineering companies that build a wide range of digital systems and from visits from guest speakers with relevant industrial experience.