Programme	Matriculation to HND in Electrical and Electronic Engineering and Mechanical Engineering
Course Title	Electrical and Electronics
Guided Learning Hours	48

Aims

This unit will develop learners understanding of fundamental Electrical and Electronic Principles through analysis of simple direct current (DC) circuits. Learners are then taken through the various properties and parameters associated with capacitance and inductance, before finally considering the application of single-phase alternating current (AC) theory. The unit will encourage an investigative approach through practical construction, measurement and testing of circuits and, where applicable, the use of computer-based circuit analysis and simulation.

Learning Outcomes

On completing this course successfully learners will be able to:

1. Use circuit theory to determine voltage, current and resistance in direct current (DC) circuits
2. Understand the concepts of capacitance and determine capacitance values in DC circuits
3. Understand the principles and properties of magnetism
4. Use single-phase alternating current (AC) theory.

Indicative Content

1. **Use circuit theory to determine voltage, current and resistance in direct current (DC) circuits**

DC circuit theory: Voltage e.g. potential difference, electromotive force (e.m.f); Resistance e.g. conductors and insulators, resistivity, temperature coefficient, internal resistance of a DC source; Circuit components (power source e.g. cell, battery, stabilized power supply; Resistors e.g. function, types, values, color coding; diodes e.g. types, characteristics, forward and reverse bias modes); Circuit layout (DC power source, resistors in series, resistors in parallel, series and parallel combinations); Ohm's law, power and energy formulae e.g. $V = IR$, $P = IV$, $W = Pt$, application of Kirchhoff's voltage and current laws.

DC networks: Networks with one DC power source and at least five components e.g. DC power source with two series resistor and three parallel resistors connected in a series parallel arrangement; Diode Resistor circuit with DC power source, series resistors and diodes.

Measurements in DC circuits: Safe use of a Multimeter e.g. setting, handling, health and safety; Measurements (circuit current, voltage, resistance, internal resistance of a DC power source, testing a diode's forward and reverse bias).

2. **Understand the concepts of capacitance and determine capacitance values in DC circuits**

Capacitors: State that the function of a capacitor is to store a small amount of electrical energy in an electric field set up between its plates; State that capacitance is measured in Farads(F) and explain the use of sub units (sub units: mF, µF, nF and pF); State the types of capacitor in general use in electronics (Types of capacitors: silvered mica, polyester, polystyrene, mylar, tantalum and electrolytic); Explain the need for observing the correct voltage polarity when connecting electrolytic capacitors; Describe the system of numerical coding used to identify the capacitance and tolerance of capacitors. Identify series and parallel connections of capacitors and for each connection state the formula for the equivalent capacitance of the combination; Draw the internationally accepted circuit symbols for various types of capacitors (Capacitors: non-polarized, electrolytic, variable, pre-set).

3. Understand the principles and properties of magnetism

Magnetic field: Magnetic field patterns e.g. flux, flux density (B), magnetomotive force (mmf) and field strength (H), permeability, B/H curves and loops; Ferromagnetic materials; Reluctance; magnetic screening; hysteresis; relationship between flux area and flux density.

Electromagnetic induction: principles e.g. induced electromotive force (e.m.f), eddy currents, self and mutual inductance; applications (electric motor/generator e.g. series and shunt motor/generator; transformer e.g. primary and secondary current and voltage ratios); application of Faraday's and Lenz's laws

4. Understand the operational principles of Diodes and Transistors

Diodes: State that the function of an ideal diode is to allow current to pass in one direction only; Define p-type and n-type semi-conductor material and explain a flow of current in terms of the movement of positive and negative charge carriers; State that a diode is constructed when a pn junction is formed and the direction of current through the junction, when it is forward biased, is from the p to n; The connections to the diode are termed anode(p) and cathode(n) respectively; Distinguish between rectifier and signal diodes; Describe the practical polarity markings for indicating the cathode connection of a diode; Explain Zener or voltage reference diodes

Transistors: State the types of junction (bipolar) transistors (Types: npn, pnp); Draw the internationally agreed circuit symbols for npn and pnp transistors; Describe the three main functions of a transistor; Describe the conditions required for a transistor to conduct (Conditions: emitter-base junction forward biased, base collector junction reverse biased); State that the voltage across the emitter-base junction when the transistor is conducting normally is approximately 0.6V for a silicon transistor; Draw circuit

diagrams and explain the operation of a common emitter amplifier with simple and stabilized biasing; Explain the terms ‘input resistance’ and ‘current gain’ and state that the symbols used to denote these two characteristics are ‘h_{ie}’ and ‘h_{fe}’ respectively for a common emitter connected transistor; Explain that a common emitter connected transistor acts as a switch when the forward bias on the base
emitter junction causes sufficient collector current to flow through the collector load to reduce the collector voltage to the saturation voltage V_{sat}, which is less than the base emitter voltage; State typical applications of transistor switching circuits.

5. Use single-phase alternating current (AC) theory

Single phase AC circuit theory: Waveform characteristics e.g. sinusoidal and non-sinusoidal waveforms, amplitude, period time, frequency, instantaneous, peak/peak-to-peak, root mean square (rms), average values, form factor; determination of values using phasor and algebraic representation of alternating quantities e.g. graphical and phasor addition of two sinusoidal voltages, reactance and impedance of pure R, L and C components

AC circuit measurements: Safe use of an oscilloscope e.g. setting, handling, health and safety; Explain the functions of the main controls of an oscilloscope (Controls: channel gain, time base speed, sync/trigger, time base mode (alternate scan or switching)); Describe applications of the oscilloscope (Applications: waveform observation, measurement of amplitude, time, frequency and phase); Describe the use of probes to improve the performance of oscilloscopes and electronic instruments at high frequencies (Types of probe: low capacitance, multiplier, rectifier); Define the terms ‘resolution’ and ‘accuracy’ of instruments and determine typical values from manufacturer’s data; Calculate errors in instrument readings and the tolerance which must be applied arising from practical limitations (Limitations: loading due to instrument impedance, resolution and accuracy of the instrument); Describe the operation and use of a simple logic probe.

Learning Outcomes

Candidates will be able to:

1. Use circuit theory to determine voltage, current and resistance in direct current (DC) circuits

- 1.1 Explain what is meant by potential difference, electromotive force, resistance and resistivity.
- 1.2 Apply Ohm's law to solve problems involving resistors in series, parallel and series and parallel combinations.
- 1.3 Apply Kirchhoff's voltage and current laws to solve problems involving resistors in series, parallel and series and parallel combinations.
- 1.4 Demonstrate the ability to use a Multimeter to take various measurement readings involving DC circuits.

2. Understand the concepts of capacitance and determine capacitance values in DC circuits

- 2.1 Be able to state the function of a capacitor and identify the various types of capacitors used in electronics.
- 2.2 Apply the numerical coding to allow for the accurate determination of the capacitance and tolerance of various capacitors.
- 2.3 Solve problems involving capacitors in series and parallel combinations.

3. Understand the principles and properties of magnetism

- 3.1 Be able to define Flux, Flux density and magenetomotive force.
- 3.2 Explain the principles of Electromagnetic induction.
- 3.3 Explain at least two applications of electromagnetic induction.
- 3.4 Carry out calculations involving transformers to determine primary and secondary currents and voltages.

4. Understand the operational principles of Diodes and Transistors

- 4.1 Be able to state the function of a Diode.
- 4.2 Explain the construction and operation of at least one type of diode.
- 4.3 Distinguish between rectifier and signal diodes.
- 4.4 Explain what is meant by a Zener or voltage diode.
- 4.5 Describes the main functions of a transistor.

4.6 State the various types of transistors
4.7 Describe the conditions required for the transistor to conductor.
4.8 Explain the operation of a common emitter amplifier.

5. Use single-phase alternating current (AC) theory

5.1 Analyze various waveforms and determine amplitude, period, frequency, peak, root mean square values.
5.2 Demonstrate the ability to use an Oscilloscope.
5.3 Define the terms 'resolution' and 'accuracy'
5.4 Perform calculations involving errors in instrument readings.
5.5 Describe the operation and use of a simple logic probe.

Outline Learning Plan:

The outline learning plan has been included in this unit as guidance. It demonstrates one way of planning the delivery and assessment of this unit.

Topic and suggested assignments/Activities	Hours
Tutor led introduction to unit and programme of learning	0.5
Tutor Introduction to DC circuit theory: Basic theory involving Ohm's law principles.	1.9
Understanding DC circuit theory: Voltage e.g. potential difference, electromotive force (e.m.f); Resistance e.g. conductors and insulators, resistivity, temperature coefficient, internal resistance of a DC source; Circuit components (power source e.g. cell, battery, stabilized power supply; Resistors e.g. function, types, values, color coding; diodes e.g. types, characteristics, forward and reverse bias modes); Circuit layout (DC power source, resistors in series, resistors in parallel, series and parallel combinations); Ohm's law, power and energy formulae e.g. V = IR, P = IV, W = Pt, application of Kirchhoff's voltage and current laws.	2.4
Understanding DC networks: Networks with one DC power source and at least five components e.g. DC power source with two series resistor and three parallel resistors connected in a series parallel arrangement; Diode Resistor circuit with DC power source, series resistors and diodes.	2.4
Tutor led Practical Activity: Measurements in DC circuits: Safe use of a Multimeter e.g. setting, handling, health and safety; Measurements (circuit current, voltage, resistance, internal resistance of a DC power source, testing a diode's forward and reverse bias).	2.4
Understanding the concepts of capacitance and determine capacitance values in DC circuits: State that the function of a capacitor is to store a small amount of electrical energy in an electric field set up between its plates; State that capacitance is measured in Farads(F) and explain the use of sub units (sub units: mF, µF, nF and pF); State the types of capacitor in	2.4

general use in electronics (Types of capacitors: silvered mica, polyester, polystyrene, mylar, tantalum and electrolytic).	
Understanding the need for observing the correct voltage polarity when connecting electrolytic capacitors; Describe the system of numerical coding used to identify the capacitance and tolerance of capacitors. Identify series and parallel connections of capacitors and for each connection state the formula for the equivalent capacitance of the combination; Draw the internationally accepted circuit symbols for various types of capacitors (Capacitors: non-polarized, electrolytic, variable, pre-set).	2.4
Tutor led Practical Activity: : Measurement of equivalent capacitance in series and parallel; Observe the charge and discharge curves of a capacitor through a load resistor on the oscilloscope.	2.4
Tutor Introduction to Magnetism. Basic concept and principles of a magnetic field.	2.4
Understanding Magnetic field: Magnetic field patterns e.g. flux, flux density (B), magnetomotive force (mmf) and field strength (H), permeability, B/H curves and loops; Ferromagnetic materials; Reluctance; magnetic screening; hysteresis; relationship between flux area and flux density.	2.4
Understanding Electromagnetic induction: principles e.g. induced electromotive force (e.m.f), eddy currents, self and mutual inductance; applications (electric motor/generator e.g. series and shunt motor/generator; transformer e.g. primary and secondary current and voltage ratios); application of Faraday's and Lenz's laws.	2.4
Tutor led Practical Activity: Learners are required to construct and examine the induced voltage across ballast in a fluorescent lighting circuit due to an induced voltage in the coil. Measurements of the voltage across the coil are to be observed using a voltmeter.	2.4
Tutor Introduction to Diodes and Transistors: Various types including their applications in electronics	2.4
Understanding the function of an ideal diode is to allow current to pass in one direction only; Define p-type and n-type semi-conductor material and explain a flow of current in terms of the movement of positive and negative charge carriers; State that a diode is constructed when a pn junction is formed and the direction of current through the junction, when it is forward biased, is from the p to n; The connections to the diode are termed anode(p) and cathode(n) respectively; Distinguish between rectifier and signal diodes; Describe the practical polarity markings for indicating the cathode connection of a diode; Explain Zener or voltage reference diodes.	2.4
Identifying the types of junction (bipolar) transistors (Types: npn, pnp); Draw the internationally agreed circuit symbols for npn and pnp transistors; Describe the three main functions of a transistor; Describe the conditions required for a transistor to conduct (Conditions: emitter-base junction forward biased, base collector junction reverse biased); State that the voltage across the emitter-base junction when the transistor is conducting normally is approximately 0.6V for a silicon transistor.	2.4
Understanding the operation of a common emitter amplifier with simple and stabilized biasing; Explain the terms 'input resistance' and 'current gain' and state that the symbols used to denote these two characteristics are 'hie' and 'hfe' respectively for a common	2.4

emitter connected transistor; Explain that a common emitter connected transistor acts as a switch when the forward bias on the base emitter junction causes sufficient collector current to flow through the collector load to reduce the collector voltage to the saturation voltage Vsat, which is less than the base emitter voltage; State typical applications of transistor switching circuits.	
Tutor led Practical Activity: Learners build and test a common emitter amplifier with source biasing. Using a signal generator, apply a small signal (AC) and record the output obtained from the circuit.	2.4
Tutor Introduction to Single phase alternating current: Production of a sinusoidal waveform from an AC generator.	2.4
Understanding waveform characteristics e.g. sinusoidal and non-sinusoidal waveforms, amplitude, period time, frequency, instantaneous, peak/peak-to-peak, root mean square (r.m.s), average values, form factor; determination of values using phasor and algebraic representation of alternating quantities e.g. graphical and phasor addition of two sinusoidal voltages, reactance and impedance of pure R, L and C components.	2.4
Tutor led Practical Activity: Safe use of an oscilloscope e.g. setting, handling, health and safety; Explain the functions of the main controls of an oscilloscope (Controls: channel gain, time base speed, sync/trigger, time base mode (alternate scan or switching)); Describe applications of the oscilloscope (Applications: waveform observation, measurement of amplitude, time, frequency and phase); Describe the use of probes to improve the performance of oscilloscopes and electronic instruments at high frequencies (Types of probe: low capacitance, multiplier, rectifier); Define the terms 'resolution' and 'accuracy' of instruments and determine typical values from manufacturer's data; Calculate errors in instrument readings and the tolerance which must be applied arising from practical limitations (Limitations: loading due to instrument impedance, resolution and accuracy of the instrument); Describe the operation and use of a simple logic probe.	2.4
Review of learning outcomes 1 to 5/ Feedback and guidance	2.4
TOTAL LEARNING CONTACT HOURS	**48**

Assessment Details

Methods of Assessment	Mid-term Examination	End of Term Examination
Grading Mode	Numeric	Numeric
Weighting %	40	60
Pass Mark%	50 overall	
Outline Details	Three hour unseen closed book examination. (8) structured questions	Three hour unseen closed book examination. (10) structured questions

Essential Learning Resources:

Learners will be given access to a wide range of publications relating to Electrical and Electronics from our library facility as well as access to the online EBSCO database. In addition Learners will access to our well-equipped electrical and electronics laboratory for practical training relating to this unit.

Textbooks and Manuals

1. Bird J – Electrical and Electronic Principles and Technology (Newnes, 2004) ISBN 0750665505
2. Bird J – Electrical Circuit Theory and Technology (Newnes, 2004) ISBN 0750657847
3. Robertson C R – Fundamental Electrical and Electronic Principles (Butterworth-Heinemann, 2001) ISBN 0750651458