Programme	Matriculation to HND in Electrical and Electronic Engineering and Mechanical Engineering
Course Title	**Electronic Devices and Circuit Analysis**
Guided Learning Hours	**48**

Aims

This unit provides a practical introduction to basic electronic devices and analogue and digital electronic principles. It provides learners with an opportunity to investigate the operation of diodes and transistors, two of the most important building blocks in electronic circuits. Learners will then go on to build and test circuits that make use of these devices and will consider the operation of integrated circuits such as the operational amplifier. Logic gates and flip-flops are also investigated both in practice and by using simple electronic principles, such as voltage gain or truth tables.

Learning Outcomes

On completing this course successfully learners will be able to:

1. Understand the function and operation of diodes and transistors
2. Understand the function and operation logic gates
3. Be able to build and test operational amplifier-based analogue circuits
4. Be able to build and test combinational and sequential logic circuits

Indicative Content

1. Understand the function and operation of diodes and transistors

Diodes: Describe the function and operation of the following types of diodes (Zener, light emitting diode (LED), PN-junction); Explain the flow of current in terms of the movement of positive and negative charge carriers; Distinguish between rectifier and signal diodes; Describe typical applications of diodes (voltage stabilizer, indicator light, half-wave rectifier).

Transistors: Describe the main functions of a transistor (to amplify ac and dc signals, to act as a switch, to act as an electronically controlled variable resistor); Describe the operation of the following types of transistors (NPN, PNP or field-effect transistor (FET)); Explain the conditions required for a transistor to conduct; Using circuit diagrams, explain the operation of a common emitter amplifier with simple

stabilized biasing; Explain the terms 'input resistance' and 'current gain'; State typical applications of transistor switching circuits (relay control, LED control, pulse squaring circuits).

2. Understand the function and operation of logic gates

Logic gates: Explain using truth tables the operation of a range of 2 input logic gates (Logic gates: AND, OR, NAND, NOR, XOR); Reduce simple Boolean expressions using logical relationships; Construct combinational gate systems to implement simple Boolean expressions or truth tables; Explain the need for a latch; Draw the circuit and explain the operation of a simple RS latch; Explain with the aid of a logic diagram the operation of the cross-coupled NAND or NOR gates.

3. Be able to build and test operational amplifier-based analogue circuits

Analog Circuits: Describe various methods of construction (prototype/bread-board, printed circuit, strip board); Explain the various modes(classes) of operation used in amplifiers; Calculate the voltage and current gains of (2) stage amplifiers using the appropriate equivalent circuits; Define bandwidth and sketch typical signal frequency curves (gain db. against logarithmic frequency); Describe the characteristics and operation of a range of operational amplifiers incorporating resistor capacitor networks (types: integrator, ac coupled amplifier having a high pass frequency response); Describe the operation of a 3-stage RC phase shift oscillator; Describe the operation of a single tuned- circuit oscillator; Calculate the gain and frequency of RC and tuned-circuit oscillators; Calculate the mid band voltage gains and bandwidths of high-pass and low-pass operation amplifier circuits given typical component values;

Testing analogue circuits: Performance against given design requirement; Recording actual input and output voltages (tabulating data, plotting graph of results); Circuit measurements (measurement of resonant frequency, cut-off frequency, switching point, gain at mid-frequency, scale).

4. Be able to build and test combinational and sequential logic circuits

Analog circuits: Types of circuits (transistor amplifier, op-amp, active filter, rectifier); Types of components (resistor, capacitor, transistor, diode); Instrument measurement actual/simulation (voltmeter, ammeter, oscilloscope); Records of performance against given design requirements (screen print, input/output waveforms (with scales), gain-frequency response).

Digital circuit: Types of circuits (three input combinational circuit, counter, shift register); Types of gates/sequential circuit (R-S bi-stables, JK bi-stable, 3-stage counter, 3-stage shift-register based on JK or D-type bi-stables); Instrument measurement actual/simulation (on/off indicator, logic probe, word generator, logic analyzer); Records of performance against given design requirements (screen print, digital input/output waveforms).

Learning Outcomes

Candidates will be able to:

1. Understand the function and operation of diodes and transistors

1.1 Describe the function and operation of various types of diodes.
1.2 Distinguish between rectifier and signal diodes
1.3 Describe typical applications of diodes.
1.4 Describe the main functions of a transistor.
1.5 Explain the operation of a least (2) types of transistors.
1.1 State typical applications of transistor switching circuits.

2. Understand the function and operation of diodes and transistors

2.1 Explain the operation of logic gates using truth tables.
2.2 Solve problems involving truth table, Boolean expressions and combination gate systems.
2.3 Explain the operation of cross coupled NAND or NOR gates.

3. Be able to build and test operational amplifier-based analogue circuits

3.1 Describe various methods of construction of analog circuits.
3.2 Describe the characteristics and operation of a range of operational amplifiers.
3.3 Describe the operation of a 3-stage RC phase shift oscillator.
3.4 Calculate the voltage and current gains of two stage amplifiers.
3.5 Calculate the mid band voltage gains and bandwidths of high-pass and low-pass operation amplifier circuits.
3.6 Test various analog circuits by taking measurements such as input and output voltages and frequency.

4. Be able to build and test combinational and sequential logic circuits

4.1 Be able to build and test various analog and digital circuits in the lab.
4.2 Be able to constructions and test various analog and digital circuits using suitable simulation software.

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	0.6
Tutor led discussion introducing types of electronic components and the meaning and difference between Analog and Digital Electronics	1.8
Understanding what are Diodes and the different types – Learners develop understanding of operation ,construction and application of small signal and rectifier diodes types, Zener and led's diodes	2.4
Understanding Common Circuits employing Diodes: Learners are presented the theory of operation of a Voltage Regulator, Rectifiers (Bridge, Full wave) circuit	2.4
Tutor led Practical Activity: Learners are presented various PN Diodes, Zener and LED diodes components and demonstrated how to conduct instrumentation test for open and short circuit conditions as well as perform testing of components under supply dc voltage conditions to confirm components characteristics.	2.4
Tutor led Practical Activity: Learners construct a Full Wave rectifier circuit using a breadboard and supplied electronic components and perform instrumentation testing of circuit to confirm proper operation.	2.4
Understanding different types of Transistors and their Operation : Learners develop an understanding of BJT and FET's transistors construction and operation theory	2.4
Learners are presented Transistor Applications using a Common Emitter, Common Source Amplifier and Switching Circuits theory of operation as an example followed by tutor led practical led activity where learners construct and build a Transistor Switching Circuit with provided electronic components and breadboard, and use instrumentation testing to confirm proper operation.	2.4
Tutor led Practical Activity: Learners are provided electronic components and perforated board to construct a Single Stage Common Emitter Amplifier Circuit Build from a provided schematic circuit diagram then perform instrumentation test to record voltage gain of circuit under operational conditions.	2.4
Understand Basic Logic Gates and Truth Tables Operations: Learners are presented the theory of operation for OR, NOR, AND, NAND, NOT, XOR & XNOR logic gates using switches as an analogy for understanding with their associated truth tables using both BS and American Military Symbols Standards	2.4
Leaners are introduced to Boolean Algebra and their formation and then a demonstration is made to illustrate how to simplify Boolean expressions (Logic minimization) with reasons for doing so, using the laws of Boolean algebra. Learners are also shown how to derive Boolean expressions from a given truth tables	2.4

Tutor led demonstrates how to implement Combinational Logic circuit diagrams from Boolean expressions by examples and then show how to derive the Boolean expression from Combinational Logic Diagrams	2.4
Tutor led Practical Activity: Learners construct circuits for Cross Coupled NAND and NOR Latches with provided logic gates and observe and record their operation, then use their recorded observations to derive their truth table operation	2.4
.Understand Sequential Logic Circuit Operation and their applications: Tutor describes the operation of typical Bistable, Shift Registers and Counters to learners with typical applications for each	2.4
Understand Different Electronic Circuits Construction Methods: Learners are presented theory of PCB, Breadboard, Thru- Hole Mount, SMT, Strip-Board manufacturing by way of video presentation format followed by group discussion on advantages , disadvantages and suitability of application for each method	2.4
Tutor led Practical Activity: Tutor led demonstration on using various Electronic CAD software to construct and simulate a given circuit design and perform various analysis followed by learners doing the same with a given circuit diagram:	2.4
Leaners are presented the theory of the characteristics/ operation , voltage gains of Inverting, Non-Inverting, Integrator, AC low and high pass coupled operational amplifiers with applications for each types	2.4
Tutor led Practical Activity: Learners construct an Inverting Op- Amp with provided electronic components on breadboard and use an oscilloscope to determine the voltage gain and operating bandwidth	2.4
Understand the operation of Oscillators: Learners develops an understanding for oscillator operations with emphasis on the Tuned Oscillator and the 3 -Stage RC Phase Shift oscillator and their applications	2.4
Determining voltage gain of Multistage Amplifiers: Learner is introduce to the use of the dB unit as applied to represent gain of amplifiers and perform calculations for total gain of amplifiers connected in cascade and drawing equivalent circuits of amplifiers	2.4
Feedback and guidance on assignments	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	Two hour unseen closed book examination. (6) 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 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. Tooley M – Electronic Circuits – Fundamentals and Applications (Newnes, 2006)
   ISBN 0750669233