OYAM INSTITUTE OF SCIENCES AND TECHNOLOGY
Strive for Distinctiveness
P.O Box 361242 Gulu | Minakulu Owino Off Kampala - Gulu Highway, 120meters along Oyam District quarters Road
Opposite Minakulu Health Centre III - Uganda | Tel: +256784524102 | info@oist.edu.ug | www.oist.ac.ug

ELECTRICAL ENGINEERING SCIENCE FOR BIOMEDICAL ENGINEERING (DIPLOMA)

OIST Online · Engineering & Applied Sciences · course outline
Issued 22 November 2026

Level	**Beginner**
Duration	**4 months**
Weekly effort	**About 4–5 hours a week (67 hours in total)**
Content	**8 modules · 181 lessons · 67 h 30 min**
Format	**Online, self-paced**
Fee	**Free**
Certificate	**Certificate of Completion**
Instructor	**OIST Department of Biomedical Engineering, Oyam Institute of Sciences and Technology**

The electrical science behind every hospital machine: circuits, magnetism, AC, transformers, motors and the power grid. Learn through short videos, 3D models and hands-on labs at your own pace, and prepare for UVTAB scenario-based exams.

WHAT YOU WILL LEARN

- Analyse DC circuits using Ohm's law, series–parallel rules, current division and Kirchhoff's laws
- Calculate power, energy and the electricity bill of a health facility
- Explain the effect of temperature on resistance and use RTC in sensor problems
- Solve simple magnetic circuits and compare them with electric circuits
- Apply Faraday's and Lenz's laws and Fleming's rules to generators, motors and relays
- Calculate RMS, average, form factor and peak factor of AC waveforms
- Analyse R, L, C, R–L, R–C and R–L–C circuits and draw phasor diagrams and power triangles
- Explain three-phase supply, phase sequence and star–delta relationships
- Describe transformer construction, types and losses, and calculate turns, voltage and current ratios
- Select and fault-find DC, induction, universal, stepper and servo motors in medical equipment
- Draw and explain the single-line diagram of Uganda's power system from generation to the hospital socket
- Build, measure and verify circuits safely in the laboratory
- Answer UVTAB scenario-based questions with confidence

REQUIREMENTS

- Enrolled in the OIST Diploma in Biomedical Engineering (or a related diploma)

- O-level Mathematics and Physics
- A scientific calculator
- A smartphone or computer with about 1–2 GB of internet a month
- Access to the OIST electrical laboratory for the practical labs

ABOUT THIS COURSE

About this course

Every patient monitor, X-ray unit, infusion pump and vaccine fridge runs on the same electrical principles. This course teaches those principles through the equipment you will maintain in Ugandan health facilities, from a Health Centre II to a regional referral hospital.

How you learn

What is inside

1. Fundamentals: Ohm's and Kirchhoff's laws, energy and the electricity bill (7 hours)
2. Magnetism and electromagnetic induction (10 hours)
3. AC fundamentals: phasors, RMS, R–L–C circuits, power factor, three-phase (13 hours)
4. Transformer (5 hours)
5. Electrical machines: DC, induction, universal, stepper and servo motors (9 hours)
6. Electrical power system: from the Nile to the ward (8 hours)
7. Practical labs: eleven graded labs (15 hours)
8. UVTAB exam clinic: three timed mock papers

Study at your own pace

There are no live classes and no fixed deadlines. A suggested 16-week plan is included, and you book lab time when you are ready.

Assessment

Seven unit tests, eleven graded lab assignments and three mock papers. Every answer comes with an explanation.

Offered by Oyam Institute of Sciences and Technology, Minakulu, Oyam.

COURSE CONTENT

Module 1 · EES-U1 · Unit 1 — Fundamentals

7 hours, 10 lessons. Definitions of electrical and electronic terms; current, emf, potential difference, resistance, work, power and energy; laws of resistance, resistivity and RTC; types of resistors; AC and DC; Ohm's law, series and parallel, current division; ideal and practical sources; node, branch, loop, mesh and Kirchhoff's laws; appliance ratings and the electricity bill. Ends with the Unit 1 test.

#	LESSON	TYPE	MINUTES
1	Welcome · Learn at your own pace: how to use this course (start here)	Reading	5
2	Unit 1 · Overview	Reading	2
3	Start here · Standard electrical symbols and how to draw circuit diagrams (reading)	Reading	30

#	LESSON	TYPE	MINUTES
4	Lesson 1.1 · Watch: Electrical vs electronic (video)	Video	10
5	Lesson 1.1 · Electrical vs electronic: definitions and why electronics matters in medicine	Reading	30
6	Lesson 1.2 · Watch: Voltage and potential difference explained (video)	Video	12
7	Lesson 1.2 · Current, emf, potential and potential difference	Reading	30
8	Lesson 1.2 · Watch more: How electricity works — animated (video)	Video	10
9	Lesson 1.2 · Explore in 3D: the digital multimeter (3D model)	3D model	8
10	Lesson 1.3 · Watch: Electric power and the cost of electricity (video)	Video	12
11	Lesson 1.3 · Resistance, work, power and energy	Reading	30
12	Lesson 1.4 · Watch: Resistance and the laws of resistance (video)	Video	10
13	Lesson 1.4 · Laws of resistance and resistivity	Reading	25
14	Lesson 1.5 · Watch: Temperature coefficient of resistance with calculations (video)	Video	12
15	Lesson 1.5 · Temperature and resistance (RTC) and types of resistors	Reading	35
16	Lesson 1.6 · Watch: AC and DC electricity basics (video)	Video	5
17	Lesson 1.6 · The concept of AC and DC	Reading	20
18	Lesson 1.7 · Watch: Ohm's law explained (video)	Video	12
19	Lesson 1.7 · Ohm's law, series and parallel circuits, current division	Reading	45
20	Lesson 1.7 · Watch: Solving series–parallel circuits step by step (video)	Video	12
21	Lesson 1.7 · Explore in 3D: real resistors, capacitors and a breadboard (3D model)	3D model	8
22	Lesson 1.7 · Explore in 3D: the extension cord is a parallel circuit (3D model)	3D model	5
23	Lesson 1.8 · Watch: Ideal vs practical voltage sources (video)	Video	8
24	Lesson 1.8 · Voltage and current sources: ideal and practical	Reading	30
25	Lesson 1.9 · Watch: Kirchhoff's current and voltage laws with worked examples (video)	Video	20
26	Lesson 1.9 · Node, branch, loop, mesh and Kirchhoff's laws	Reading	45
27	Lesson 1.10 · Watch: What is a kWh? Energy bill calculations (video)	Video	10
28	Lesson 1.10 · Appliance ratings and calculating the electricity bill	Reading	35
29	Unit 1 · Draw & memorise: circuit diagrams (reading)	Reading	40
30	Unit 1 test · Fundamentals (scenario questions)	Quiz	25

Module 2 · EES-U2 · Unit 2 — Magnetism and Electromagnetic Induction

10 hours, 8 lessons. Flux, flux density, field strength, mmf, reluctance and permeability; electric vs magnetic circuits; B–H curve; hysteresis and its loss; Faraday's and Lenz's laws; Fleming's right- and left-hand rules; statically and dynamically induced emf; self and mutual inductance. Ends with the Unit 2 test.

#	LESSON	TYPE	MINUTES
1	Unit 2 · Overview	Reading	2
2	Lesson 2.1 · Watch: Magnetomotive force and reluctance (video)	Video	12
3	Lesson 2.1 · Flux, flux density, field strength, mmf, reluctance and permeability	Reading	45
4	Lesson 2.1 · Explore in 3D: an electromagnet switching on and off (3D animation)	3D model	6
5	Lesson 2.2 · Watch: Magnetic circuit vs electric circuit (video)	Video	8
6	Lesson 2.2 · Comparing electric and magnetic circuits	Reading	30
7	Lesson 2.2 · Watch: How relays work — the magnetic circuit in action (video)	Video	10
8	Lesson 2.3 · Watch: Magnetisation (B–H) curve (video)	Video	12
9	Lesson 2.3 · The magnetisation (B–H) curve	Reading	30
10	Lesson 2.4 · Watch: The hysteresis loop explained (video)	Video	10
11	Lesson 2.4 · Magnetic hysteresis, the hysteresis loop and hysteresis loss	Reading	40
12	Lesson 2.5 · Watch: Faraday's law of electromagnetic induction (video)	Video	15
13	Lesson 2.5 · Faraday's laws and Lenz's law	Reading	40
14	Lesson 2.5 · Explore in 3D: electromagnetic induction (3D animation)	3D model	6
15	Lesson 2.6 · Watch: Fleming's left-hand and right-hand rules (video)	Video	10
16	Lesson 2.6 · Fleming's right-hand rule (generators) and left-hand rule (motors)	Reading	30
17	Lesson 2.7 · Watch: Statically vs dynamically induced emf (video)	Video	8
18	Lesson 2.7 · Statically and dynamically induced emf	Reading	35
19	Lesson 2.8 · Watch: Self and mutual inductance (video)	Video	20
20	Lesson 2.8 · Self and mutual inductance	Reading	40
21	Unit 2 · Draw & memorise: magnetism diagrams (reading)	Reading	40
22	Unit 2 test · Magnetism and electromagnetic induction	Quiz	25

Module 3 · EES-U3 · Unit 3 — AC Fundamentals

13 hours, 12 lessons. Generating AC; cycle, period, frequency, amplitude, phase; phasors and equations; average, RMS, form and peak factor; AC through R, L and C; R–L, R–C and R–L–C series and parallel circuits; power, power factor and the power triangle; three-phase supply, phase sequence, star and delta. Ends with the Unit 3 test.

#	LESSON	TYPE	MINUTES
1	Unit 3 · Overview	Reading	2
2	Lesson 3.1 · Watch: Working principle of the AC generator (video)	Video	6
3	Lesson 3.1 · Principle of generating an alternating voltage	Reading	30
4	Lesson 3.1 · Explore in 3D: a real alternator (3D scan)	3D model	6
5	Lesson 3.2 · Watch: Cycles, period and frequency in AC circuits (video)	Video	8
6	Lesson 3.2 · Cycle, time period, frequency and amplitude	Reading	25
7	Lesson 3.2 · Explore in 3D: the oscilloscope that shows AC waveforms (3D model)	3D model	6
8	Lesson 3.3 · Watch: Phasors and the phasor diagram (video)	Video	12
9	Lesson 3.3 · Phase, phase difference and phasor (vector) representation	Reading	35
10	Lesson 3.4 · Watch: Calculating instantaneous voltage (video)	Video	6
11	Lesson 3.4 · Mathematical representation of alternating emf and current	Reading	25
12	Lesson 3.5 · Watch: What the RMS value really means (video)	Video	8
13	Lesson 3.5 · Average value, RMS value, form factor and peak factor	Reading	40
14	Lesson 3.6 · Watch: AC through a pure resistor (video)	Video	8
15	Lesson 3.6 · AC through a pure resistor	Reading	25
16	Lesson 3.7 · Watch: Pure inductor on AC (video)	Video	10
17	Lesson 3.7 · AC through a pure inductor	Reading	30
18	Lesson 3.7 · Watch more: What an inductor really does (video)	Video	10
19	Lesson 3.8 · Watch: AC through a pure capacitor (video)	Video	8
20	Lesson 3.8 · AC through a pure capacitor	Reading	30
21	Lesson 3.8 · Watch more: What a capacitor really does (video)	Video	9
22	Lesson 3.9 · Watch: R–L series circuit and phasor diagram (video)	Video	12
23	Lesson 3.9 · R–L series and R–C series circuits	Reading	45
24	Lesson 3.10 · Watch: Series R–L–C circuits and resonance, worked step by step (video)	Video	11
25	Lesson 3.10 · R–L–C series and parallel circuits and resonance	Reading	50

#	LESSON	TYPE	MINUTES
26	Lesson 3.10 · Watch more: Parallel R–L–C circuit, worked example (video)	Video	11
27	Lesson 3.11 · Watch: Apparent, reactive and real power (video)	Video	20
28	Lesson 3.11 · Power in AC circuits, power factor and the power triangle	Reading	50
29	Lesson 3.11 · Watch more: active, reactive and apparent power animated (video)	Video	9
30	Lesson 3.12 · Watch: How three-phase electricity works (video)	Video	8
31	Lesson 3.12 · Three-phase supply: advantages, phase sequence, star and delta	Reading	45
32	Lesson 3.12 · Watch more: Why three phases? (video)	Video	10
33	Unit 3 · Draw & memorise (part 1): waves, phasors and the R–L circuit (reading)	Reading	30
34	Unit 3 · Draw & memorise (part 2): resonance, power triangle and three-phase (reading)	Reading	30
35	Unit 3 test · AC fundamentals	Quiz	35

Module 4 · EES-U4 · Unit 4 — Transformer

5 hours, 5 lessons. Construction, working and parts; power, AF, RF, isolating, pulse and IF transformers; emf equation and voltage, current and transformation ratios; losses; autotransformers. Ends with the Unit 4 test.

#	LESSON	TYPE	MINUTES
1	Unit 4 · Overview	Reading	2
2	Lesson 4.1 · Watch: How a transformer works (video)	Video	7
3	Lesson 4.1 · Transformer construction, working and the function of each part	Reading	40
4	Lesson 4.1 · Explore in 3D: how a transformer works (3D animation)	3D model	6
5	Lesson 4.1 · Explore in 3D: a distribution transformer, outside view (3D model)	3D model	6
6	Lesson 4.2 · Watch: How isolation transformers work (video)	Video	8
7	Lesson 4.2 · Classification of transformers: power, AF, RF, isolating, pulse and IF	Reading	35
8	Lesson 4.3 · Watch: Transformer voltage, turns and current ratios (video)	Video	8
9	Lesson 4.3 · The emf equation and voltage, current and transformation ratios	Reading	40
10	Lesson 4.4 · Watch: Energy losses in a transformer (video)	Video	6

#	LESSON	TYPE	MINUTES
11	Lesson 4.4 · Losses in transformers	Reading	30
12	Lesson 4.5 · Watch: Autotransformer and how a Variac works (video)	Video	10
13	Lesson 4.5 · Autotransformers	Reading	30
14	Unit 4 · Draw & memorise: transformer diagrams (reading)	Reading	25
15	Unit 4 test · Transformer	Quiz	20

Module 5 · EES-U5 · Unit 5 — Electrical Machines

9 hours, 7 lessons. DC machines; three-phase induction motor; single-phase induction motors; universal, stepper and servo motors — construction, types, principle and applications in medical equipment. Ends with the Unit 5 test.

#	LESSON	TYPE	MINUTES
1	Unit 5 · Overview	Reading	2
2	Lesson 5.1 · Watch: How a DC motor works (video)	Video	6
3	Lesson 5.1 · DC machines: construction and principle of working	Reading	40
4	Lesson 5.1 · Watch more: DC motor in 3D animation (video)	Video	6
5	Lesson 5.2 · Watch: DC motor types — shunt, series and compound (video)	Video	10
6	Lesson 5.2 · DC machines: types and applications	Reading	35
7	Lesson 5.3 · Watch: How three-phase induction motors work (video)	Video	10
8	Lesson 5.3 · Three-phase induction motor	Reading	45
9	Lesson 5.3 · Explore in 3D: inside a three-phase induction motor (3D cutaway)	3D model	8
10	Lesson 5.3 · Explore in 3D: take an induction motor apart (3D model)	3D model	6
11	Lesson 5.4 · Watch: Single-phase induction motor capacitors (video)	Video	8
12	Lesson 5.4 · Single-phase induction motors	Reading	40
13	Lesson 5.5 · Watch: How universal motors work (video)	Video	5
14	Lesson 5.5 · Universal motor	Reading	25
15	Lesson 5.6 · Watch: How a stepper motor works (video)	Video	6
16	Lesson 5.6 · Stepper motor	Reading	35
17	Lesson 5.6 · Watch more: Brushless DC motors (video)	Video	5
18	Lesson 5.6 · Explore in 3D: a brushless motor spinning (3D animation)	3D model	5
19	Lesson 5.7 · Watch: What is a servo motor and how it works (video)	Video	6
20	Lesson 5.7 · Servo motor	Reading	30

#	LESSON	TYPE	MINUTES
21	Unit 5 · Draw & memorise: machine diagrams (reading)	Reading	35
22	Unit 5 test · Electrical machines	Quiz	25

Module 6 · EES-U6 · Unit 6 — Electrical Power System

8 hours, 5 lessons. Single-line diagram and voltage levels; generation from conventional and non-conventional sources; transmission classification; primary and secondary distribution; types of load. Ends with the Unit 6 test.

#	LESSON	TYPE	MINUTES
1	Unit 6 · Overview	Reading	2
2	Lesson 6.1 · Watch: How electricity gets to your home — the electrical grid (video)	Video	12
3	Lesson 6.1 · Single-line diagram of the power system and voltage levels	Reading	40
4	Lesson 6.1 · Watch more: How power gets to your home — generators and transformers (video)	Video	9
5	Lesson 6.2 · Watch: Types of power plant (video)	Video	15
6	Lesson 6.2 · Generation: energy sources and types of generating stations	Reading	40
7	Lesson 6.2 · Explore in 3D: a wind turbine and its generator (3D animation)	3D model	6
8	Lesson 6.3 · Watch: Short, medium and long transmission lines (video)	Video	10
9	Lesson 6.3 · Transmission: classification by voltage, length and supply	Reading	35
10	Lesson 6.3 · Explore in 3D: a transmission tower (3D model)	3D model	5
11	Lesson 6.4 · Watch: The journey of electricity — transmission and distribution (video)	Video	5
12	Lesson 6.4 · Distribution: primary and secondary, voltage levels and number of conductors	Reading	35
13	Lesson 6.4 · Explore in 3D: walk around a real electrical substation (3D scan)	3D model	8
14	Lesson 6.5 · Watch: Types of electrical load (video)	Video	8
15	Lesson 6.5 · Types of load on the distribution system	Reading	30
16	Unit 6 · Draw & memorise: the single-line diagram (reading)	Reading	20
17	Unit 6 test · Electrical power system	Quiz	20

Module 7 · EES-U7 · Unit 7 — Practical Video Labs

15 hours, 11 labs: digital multimeter; passive and active components; lab layout and ratings; safety charts and fire extinguishers; electrical tools; Ohm's law with rheostat and meters; rheostat as current regulator and potential divider; KCL; KVL; switchboard construction; starting and reversing a three-phase induction motor. Each lab has a filmed demonstration and a graded submission.

#	LESSON	TYPE	MINUTES
1	Unit 7 · Overview	Reading	2
2	Labs at your own pace: how to do each lab (start here)	Reading	5
3	Lab circuit diagrams: draw before you wire (reading)	Reading	30
4	Lab 1 · Watch before the lab: How to use a multimeter (video)	Video	12
5	Lab 1 · Explore in 3D: practise on a digital multimeter (3D model)	3D model	5
6	Lab 1 · Operate a digital multimeter	Assignment / exam	60
7	Lab 2 · Watch before the lab: Testing electronic components with a multimeter (video)	Video	16
8	Lab 2 · Identify, test and build simple circuits with passive and active components	Assignment / exam	240
9	Lab 3 · Watch before the lab: Electrical lab rules and safety (video)	Video	8
10	Lab 3 · Watch before the lab: What is earthing? (video)	Video	9
11	Lab 3 · Watch before the lab: Why circuit breakers don't protect people (video)	Video	10
12	Lab 3 · Observe the electrical laboratory, draw its layout and list major equipment ratings	Assignment / exam	60
13	Lab 4 · Watch before the lab: Fire extinguisher tutorial — PASS (video)	Video	5
14	Lab 4 · Explore in 3D: types of fire extinguisher (3D model)	3D model	5
15	Lab 4 · Electrical safety charts and the operation of fire extinguishers	Assignment / exam	60
16	Lab 5 · Watch before the lab: Electrical hand tools (video)	Video	8
17	Lab 5 · Use of electrical tools	Assignment / exam	60
18	Lab 6 · Watch before the lab: Practical verification of Ohm's law (video)	Video	8
19	Lab 6 · Practise online first: Ohm's law in the virtual lab (simulator)	Reading	20
20	Lab 6 · Verify Ohm's law using a rheostat, ammeter, voltmeter and wattmeter	Assignment / exam	90
21	Lab 7 · Watch before the lab: Variable resistor as a voltage divider (video)	Video	5
22	Lab 7 · Practise online first: current control and voltage divider (simulator)	Reading	20
23	Lab 7 · Regulate current and divide potential using a rheostat	Assignment / exam	60

#	LESSON	TYPE	MINUTES
24	Lab 8 · Watch before the lab: Verification of Kirchhoff's current law (video)	Video	10
25	Lab 8 · Practise online first: Kirchhoff's current law (simulator)	Reading	20
26	Lab 8 · Measure branch currents using Kirchhoff's current law	Assignment / exam	60
27	Lab 9 · Watch before the lab: Verification of Kirchhoff's voltage law (video)	Video	10
28	Lab 9 · Practise online first: Kirchhoff's voltage law (simulator)	Reading	20
29	Lab 9 · Measure voltage drops in a closed loop using Kirchhoff's voltage law	Assignment / exam	60
30	Lab 10 · Watch before the lab: Switchboard connection diagram (video)	Video	8
31	Lab 10 · Watch before the lab: How an MCB trips (video)	Video	6
32	Lab 10 · Explore in 3D: a miniature circuit breaker (3D model)	3D model	5
33	Lab 10 · Build a switchboard and operate a lamp and fan load	Assignment / exam	90
34	Lab 11 · Watch before the lab: DOL starter forward–reverse operation (video)	Video	10
35	Lab 11 · Starting and reversing a three-phase induction motor	Assignment / exam	60

Module 8 · EES-U8 · Unit 8 — UVTAB Exam Clinic

How UVTAB scenario-based questions are set and marked, an answering technique, and three timed mock papers covering all six theory units, weighted by syllabus hours.

#	LESSON	TYPE	MINUTES
1	Unit 8 · Overview	Reading	2
2	How to answer UVTAB scenario-based questions	Reading	30
3	Mock paper 1 (timed)	Quiz	45
4	Mock paper 2 (timed)	Quiz	45
5	Mock paper 3 (timed)	Quiz	45

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