PHYSICS PROGRAMME ADVANCED LEVEL
Section: MATHEMATICS-PHYSICS

ADVANCED LEVEL PHYSICS PROGRAMME
FOR MATHEMATICS-PHYSICS OPTION

L. INTRODUCTION

The modem world lives in an era of technology, which govems our everyday life. We cannot immagine life without electricity; motorcars; telephone, radio and other life conveniences. Ail these practical realisations have been made possible by the progress of physical sciences and mathematics among other things. Rwanda being a developing country; needs highly qualified technicians who will appiy the physics skiils in modem technology, and this course is a step towards that goal.

This teaching programme for Mathematics-Physics option has the ambition of making a Rwandese student who understands what Physics is and what is done in Physics in order to give him flot only the desire of more Physics knowledge but also the willingness for further studies in physics sciences and Engineering.

II. GENERAL ORIENTATION

The A-Level Physics Programme is intended for students who wish to pèrsue Physics at University level and other tertiary institutions which offer courses that require a sound knowledge physics; especially Technical Institutions. The teaching method should be student centred and mainly based on observation; experimentation and discovery of laws governing physical phenomena, together with a sound knowiedge ofphysics theory.

Such a mastery of practical Physics backed by theoretical knowledge vill go a long way in developing the students' initiative for inventiveness and ability to explain the Physics phenômena.

III. GENERAL OBJECTIVES

(i) To help the learner deepen his knowledge of basic principles and concepts of Physics.
(ii) To increase the learner's capacity of persuing Physics knowledge and related disciplines at higher levels.
(iii) To equip the learner with scientific methods and techniques of solving everyday life problems in our physical environment.
(iv) To encourage the learner develop an initiative for inventiveness.
(y) To translate his knowledge of Physics into technological skills that would help him make this world a better place to live in**.**

SENIOR FOUR.

SPECIFIC OBJECTIVES:
At the end of this chapter, the learner should be able to
- Recognise the phenomenon of rejiection.
- Utilise a plane mirror to solve specfic practical problems.
- State the effecis of rotation of a plane mirror.
- Fe,forrns experiments of multiple rejiection of hightfrom plane mirrors.
- Interprete experimental resuits of multipal reflection.
- Solve problems related to rejiecrion of lightfrom plane mirrors.
- Describe a spherical mirror.
- Deterniine the image formed by graphicas method.
- Establish the formular of spherical mirrors.
- State the sign convention.
- Solve pro bléms related f0 reflection of light in spherical mirrors.
- Utilise a spherical mirror ta salve specjfic practical pro blems.
- Cite the defects of spherical mirrors.
- State the laws of refraction.
- Recognise the phenomenon of refraction.
- Explain the phenomenon of total refiection.
- Explain apparent depth.
- Solve probIems involving refraction.
- Des cribe a prism.
- State prisrnformulae.
- Utilise o prism for: - measuring refractive indess
- analysing a beam of light
- Solve problems related to a prism.
- Describè a lens.
- Give the properties of lenses
- Cite types oflenses
- Determine experimentally the focal length and the position offocalpoint ofa lens.
- Establish the lensformulae.

- State the sign convention of lenses.
- Draw a diagram of an eye, photo graphic camera, siide projector, microscope and astronomical telescope to show how theyfunction.
- Calculate magn /? cation andpower ofa microscope.
- U tilise o microscope.
- Cite the order of magnitude ofthe least angle of vision of an eye and a microscope.

Weeks	**Content**	**Method**
11/2 weeks	**PART I. GEOMETRIC OPTICS:** **CHAPTER I: REFLECTION AND ITS APPLICATIONS -** Perform experiments and establish the formulae mathematically 1.1. Laws of reflection. 1.2. Plane mirrors: (i) Reflection of light on a plane mirror (ii) Regular reflection and diffusion of light (iii) The law of reversibility of light. (vi) Formation of real and virtual image of	- Perform experiments and establish the formulae Mathematically

11/2 weeks	an object (y) Rotation of a plane mirror. (vi) Inclined mirrors and multiple images. 1.3. Spherical mirrors: - Curved mirror properties - Laws ofreflection on spherical mirrors mathematically (concave and convex) - Graphical construction of images ofobjects in spherical ‘mirrors - The mirror formulae	- Perform experiments and establish the formulae mathematically

Weeks	**Content**	**Method**
11/2 weeks	- Practical application of curved mirrors - Spherical aberration 1.4. Other types of curved mirrors: - Cylindrical mirrors - Parabolic mirrors **CHAPTER II: REFRACTION**: 2.1. Description of the phenomena of refraction 2.2. - Laws ofrefraction - - The real and apparent depth - The critical angle	- Site and indicate the instruments which use curved mirrors - Perform experiments and establish the formulae mathematically - Perform experiments using prisms

	- Total internai reflection and its practical application 2.3. Refraction through prisms: - Terms associated with refraction through a prism - Deviation ofa ray of light by a glass prism - Angle of minimum deviation and the measure- ment ofrefractive index	

Weeks	**Content**	**Method**
	- Dispersion of light by a prism. Applications: (j) Total reflecting prism 2.4. Spherical thin lenses - Types of lenses - Geometrical terms ofspherical thin lens - Images formed by converging and diverging lenses - Graphical construction of images formed by converging and diverging lenses - The lenses formula - Magnification in lenses	- Perform experiments and establish the formulae mathematically - State the defects of lenses and how they occur. - Draw diagrams showing the functions ofoptical instruments - State the defects of eye and their corrections

	- The power oflenses - Diffects of lenses : chromatic and spherical aberration CHAPTER III: SOME OPTICAL INSTRUMENTS 3.1. Simple optical instruments: (j) Camera; slide projector and the human eye	

Weeks	**Content**	**Method**
	3.2. Microscope and Telescope: - Magnifying power of these instruments	- Draw the diagram showing the microscope and its functions

ELECTRICITY (S.4 MATHEMATICS-PHYSICS)
CHAPTER I : ELECTROSTATICS
SPECIFIC OBJECTIVES

By the end of this topic; the learner should be able to:
a) Describe electrostatic charging ofmaterials.
b) State the Iwo types of charges.
c) State coulomb ‘s Law.
d) Draw electricfieldpatterns.
e) Distinguish beiween conductors and insulators.
f) Explain charge distribution on conductors ofvarious shapes.
g) Define capacitance.
h) Explain the charging and discharging ofa capacitor.
1) State thefactors affecting the cczpacitance ofa paralled plate capicitor.

j) Determine the effective capacitance for the series andparallel arrrangement.
k) State applications ofcapacitors in eveîy day i4fe.
î) Explain how lightning arrestors work.

Weeks	Content	Method
	PART II : ELECTRICITY: **CHAPITER I: ELECTROSTATICS** 1.1.Electrification by : Friction; contact and induction 1.2.Distribution of charge on the surface of a conductor 1.3.Electric charge and coulomb's Law 1.4.The concept ofelectric field 1.5.Electric intensity and unes of force: (i) Isolated charges	- Perform experiments ofelectrification - Mention the uniform distribution on a regular surface and on a sharp point Give the formular for two point chges Give the characteristics ofthe vector ofthe electric field for an electric charge Represent diagrammatically the unes of force Define flux

	(ii) Unlike charges (iii) Like charges 1.6.Electric field due to the distribution of electric charges 1.7.Flux from a point charge and Gauss's Theorem 1.8.Properties of conductors in electrostatic equi librium	Apply the definition of flux around point charge in a closed surface and deduce the Gauss's theoretfl Mention the properties - State the principle of super position

Weeks	**Content**	**Method**
4 weeks	1.9. Electrostatic potential 1.10. Potential difference 1.1 1. Electric potential energy 1.12. Relationship between electrostatic field and potential difference 1.13. Capacitors: - Parallel plate capacitors - Types of capacitors (j) Parallel plate capacitor (ii) Variable air capacitor (iii) Electrolitic capacitor - Arrangement of capacitors (series and parallel)	- Define electrostatic potential and bring the idea ofpotential difference - Establish this relationship mathematically - Give a description of a capacitor and show their' different types - Arrange the capacitors in series and parallel with students

	- Qualitative treatment of charging and discharging capacitors - Energy of a charged capacitor	

CHAPTER II: DIRECT CURRENT ELECTRICITY
SPECIFIC OBJECTIVES'
By the end ofthis topic; the learner should he able to:
a) Draw simple electric circuits.
b) Set zip simple electric circuits.
c) Define electric potential dfference.
d) Define the intensity ofelectric current.
e) State some sources of electric current.
J) Set up electric circuits invoIving ainmenters and voltmeters.

g) Define electromotive force; potental dfference and the internai resistance.
h) Apply Ohm ‘s Law to solve problems.
ï) Determine the effective resistance ofresistors in series and in parailel.
j) Measure resistance.
k) Measure the resistivity ofa material.
1) Staté Kirchoff’s Laws.
m) Detertnine the e.m.f; resistance; internai resistance andpotentiai dfference ofa combination ofceils.
n) Define back e.m.f; internai resistance andp.d. ofa receptor.
o) Determine the back e.m.f; internaI resistance andp.d. ofa receptor
p) Calculate the energy consumed in ci circuit or part ofthe circuit.
r) Explain how electric currentflows in liquids and gases.

Weeks	Content	Method
7 weeks	PART II: DIRECT CURRENT ELECTRICITY 2.1. Review of elements of simple electric circuits and their respective role 2.2. Potential difference: - Definition ofpotential difference - Potential difference as a scalar quantity - Measurement ofpotential difference: The voitmeter 2.3. Resistors and celis 2.4. Intensity of electric current - Mechanism ofmetaliic conduction: The ammeter	- Perform experiment to measure p.d. using a voltmeter - Mesure experimentally and use an ammeter to determine current - Establish the formula I = nAVE - Establish mathematically Ohm’s Law; Resistivity and Kirchoff’ s law - Estabiish the formulae relating e.m.f.

	2.5. Ohm's Law 2.6. Resistivity 2.7. Kirchhoff's Laws 2.8. Rheostat and potential divider 2.9. Combination ofresistances (series; parallel and mixture) 2.10. Sources ofelectric current: - e.m.f.; internai resjstance and potential difference a cross a celi - combination ofcells: (series : parailel and mixture)	internai resistance, externai resistance and p.d.

Weeks	**Content**	**Method**
	2.11. Electric energy and Power 2.12. Electrical receptors - Back e.m.f. internai resistance and p.d. across a receptor - Arrangement ofreceptors in series and parailel 2.13. Electric current in liquids and gases - Applications Electrolysis; Discharge tubes	

PART III : ENERGY PROBLEMS IN THE WORLD AND HOW PEOPLE TRY TO SOLVE THEM:
SPECIFIC OBJECTIVES
By the end ofthis topic, the learner shoud be able to:
- Give dfferentforms of energy.
- Give the chain of transformation of energy in.•
• A nuclear reactor
• .A thermal power station
• A hydro-electric power station A digester
- Explain thefunction o]:
• Digester
• Windm iii
• Geothermal installation
• Solar installation for cooking and Iighting

Weeks	Content	Method
	PART III : ENERGY PROBLEMS IN THE WORLD AND HOW PEOPLE TRY TO SOLVE THEM: SPECIFIC OBJECTIVES By the end ofthis topic, the learner shoud be able to: - Give dfferentforms of energy. - Give the chain of transformation of energy in.• • A nuclear reactor • .A thermal power station • A hydro-electric power station A digester	- Give the functions of each source of energy: j) Nuclear reactor ii) Thermal power station iii) Hydro Electric power station iv) Installation ofwind operated machine y) Geothermal installation vi) Solar installation vii) Digestor

	- Explain thefunction o]: • Digester • Windm iii • Geothermal installation • Solar installation for cooking and Iighting	

LIST 0F MINIMUM PHYSICS PRATICAL WORK FOR S.4. MATHS - PHYSICS

1) Reflection on a plane mirror - angular mirror - Rotation ofa mirror.
2) Study experimentally the properties of a concave spherical mirror.
3) Verify experimentally snell's Law.
4) Determination ofthe refractive index ofa prism.
5) Verify experimentally the lens formula for a converging lens.
6) Construct experimentally a graph ofpotential difference against current ofa resistor.
7) Determination ofresistivity.
8) Verify experimentally Kirchhoff'Law.
9) Construct experimentally a graph of potential difference against current of a celi.
10) Construct experimentally a graph ofpotential difference against current ofa receptor

TIMING FOR SÀ. PHYSICS TOPICS
PART I : GEOMETRIC OPTICS
CHAPTER.I : Reflection and its applications I Y2 WEEKS
1.1. Laws of reflection
1.2. Plane mirrors
1.3. Spherical mirrors 1 Y2 WEEKS
1.4. Other curved mirrors
CHAPTER II : REFRACTION:
2.1. Description of the phenomena of refraction I ‘/2 WEEKS
2.2. Laws of refraction
2.3. Refraction trhrough prisms
2.4. Spherical thin lenses 1 ‘/2 WEEKS
CHAPTER III : SOME OPTICAL INSTRUMENTS
3.1. Simple optical instruments I Y2 WEEKS

3.2. Microscope and telescope
ELECTRICITY 4 WEEKS
CHAPTER I : ELECTROSTATICS
PART. Il : DIRECT CURRENT ELECTRICITY 7 WEEKS