Electricity and Magnetism

Objectives:	00US and 00UU	**Discipline:**	Physics
Ponderation:	3-2-3	**Course Code:**	203-NYB-05

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Objectives and Standards for *Electricity and Magnetism*

Elements of Competency	Specific Performance Criteria	Intermediate Learning Objectives
	1.5. Precise use of the concepts, laws and terminology basic to the understanding of electric potential	1.5.1. State the definition of electric potential difference and of electric potential.
	1.6. Rigorous application of the concepts of electric potential and potential difference to solve mathematical problems and to answer conceptual questions in such a way as to show understanding of these concepts	1.6.1. Calculate potential differences between points in a uniform electric fibetween pand potential difference to solve State the definition 6.2erences between po T* 0

Elements of Competency	Specific Performance Criteria	Intermediate Learning Objectives
	2.2. Rigorous application of the concepts of current, resistance and power to solve various problems	2.2.1. Calculate the resistance of conductors of various geometries and of different materials, and at different temperatures. 2.2.2. Solve problems involving the interrelation of resistance, voltage, power, current and time. 2.2.3. Answer conceptual questions about these interrelations in a way that shows understanding of the concepts.
	2.3. Rigorous application of Kirchhoff's Rules to the solution of problems involving direct current circuits	2.3.1. State Kirchhoff's Rules. 2.3.2. Calculate terminal voltage and power output for circuits with a source of emf that has an internal resistance. 2.3.3. Solve for current through, voltage across and power dissipated in each resistor in a direct current circuit containing series and parallel combinations of resistors. 2.3.4. Using Kirchhoff's Rules, solve for current through, voltage across and power dissipated in individual elements of a multi-loop circuit with several sources of emf. 2.3.5. Calculate instantaneous voltages across, currents through, charge stored on and energy content of circuit elements in dc circuits with capacitors charging and discharging through a resistance. The circuits may contain series and parallel combinations of resistances and capacitors. 2.3.6. Apply Ohm's Law and circuit theory to explain the workings of the Wheatstone bridge and the potentiometer. 2.3.7. Apply Ohm's Law and circuit theory to calculate the effects of ammeters and voltmeters on the circuits in which they are used. 2.3.8. Answer conceptual questions involving electric current, voltage, resistance, power and the behaviour of series and parallel circuits.
3. To analyze physical situations involving magnetic fields and magnetic induction	3.1. Precise use of the concepts, laws and terminology basic to the understanding of magnetic forces	3.1.1. Define the magnetic field vector **B** (also called magnetic flux density or magnetic induction). 3.1.2.

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		appropriate data. **[00UU]** 3.2.3. Explain the operation of particle accelerators, particularly the cyclotron and synchrocyclotron. Perform various calculations concerning the operation of this instrument given appropriate data. **[00UU]** 3.2.4. Explain the operation of an electric motor - AC or DC. Perform various calculations concerning electric motors given appropriate data. **[00UU]** 3.2.5. Explain qualitatively the Hall effect and its use in the Hall-effect probes used to measure magnetic fields in the laboratory. 3.2.6. Calculate the force and the torque on current loops and segments in the presence of a magnetic field using vector algebra. 3.2.7. Set up and solve mathematical problems involving magnetic fields and forces using appropriate mathematical techniques. 3.2.8. Answer conceptual questions in a way that shows understanding of the concepts of magnetic fields and forces.
	3.3. Precise use of concepts, laws and terminology basic to the understanding of the production of magnetic fields	3.3.1. State the Biot-Savart Law for the determination of magnetic fields. 3.3.2. State Ampère's Law for the determination of magnetic fields. 3.3.3. Define magnetic flux. 3.3.4. State Gauss' Law for magnetism.
	3.4. Rigorous application of the laws (Biot-Savart, Ampère's and Gauss) to solve mathematical problems and answer conceptual questions involving magnetic fields and magnetic forces	3.4.1. Derive expressions for the magnetic fields due to straight or curved current carrying wires using the Biot-Savart Law and integral calculus. 3.4.2. Derive expressions for the magnetic field due to certain symmetrical current configurations using Ampère's Law, making the necessary symmetry arguments to simplify the integral. 3.4.3. Calculate the magnitude and direction of the magnetic fields due to combinations of currents. 3.4.4. Calculate the magnitude and direction of magnetic fields due to current loops, solenoids and toroids. 3.4.5. Calculate the magnetic flux for a non-uniform magnetic field through a simple area (at any angle) using the techniques of integral calculus. 3.4.6. Set up and solve mathematical problems involving magnetic fields and forces using appropriate mathematical techniques. 3.4.7. Answer conceptual questions concerning magnetic fields and forces in a way that shows understanding of the concepts of magnetic fields and forces.

Elements of Competency	Specific Performance Criteria	Intermediate Learning Objectives
	3.5. Precise use of the concepts, laws and terminology basic to the understanding of electromagnetic induction	3.5.1. State Faraday's Law of Inductance. 3.5.2. State Lenz's Law. 3.5.3. Define self-inductance. 3.5.4. Define mutual inductance.
	3.6. Rigorous application of the concepts and laws describing electromagnetic induction to solve mathematical problems and to answer conceptual questions in a way that shows understanding of them	3.6.1. Derive an expression for the emf induced in a loop by different time-varying magnetic fluxes. 3.6.2. Determine the emf produced in wires moving through magnetic fields, both uniform and non-uniform fields. 3.6.3. Apply Lenz's Law in three dimensions to determine the direction of induced current in a loop under various conditions of varying magnetic flux (changing magnetic field strength, changing area, or changing angle). 3.6.4. Describe the functioning of electric generators. **[00UU]** 3.6.5. Calculate back emf in an electric motor and explain its cause. 3.6.6. Set up and solve mathematical problems involving magnetic inductance using appropriate mathematical techniques. 3.6.7. Answer conceptual questions concerning induced currents in a way that shows understanding of the concepts of electromagnetic induction. 3.6.8. Determine the self-inductance of a solenoid. 3.6.9. Calculate as a function of time the instantaneous voltage across, the current through, and energy stored in the individual elements of a simple circuit consisting of inductors, resistances, a source of emf and a switch. 3.6.10. Determine circuit conditions, initially and after a long time has elapsed, for more complex circuits containing inductors, capacitors, resistances, a source of emf and a switch. 3.6.11. Set up and solve mathematical problems involving circuits containing combinations of inductors and resistances using appropriate mathematical techniques. 3.6.12. Answer conceptual questions concerning R-L circuits in a way that shows understanding of the concepts of inductance and circuit theory. 3.6.13. Explain the synthesis of the laws of electricity and magnetism into Maxm in

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	mathematical problems and to answer conceptual questions in a way that shows understanding of these concepts and rules	4.2.2. Calculate the current and voltage and their phase relation in an RLC circuit using phasors. 4.2.3. Calculate the power dissipated in an RLC circuit with an alternating current flowing in it. 4.2.4. Calculate voltage, current and power in a simple transformer circuit. 4.2.5. Set up and solve mathematical problems involving RLC ac circuits using appropriate mathematical techniques including phasors. 4.2.6. Answer conceptual questions about RLC ac circuits in a way that shows understanding of the concepts involved.E