Lenz’s would continue to grow indefinitely, producing

Lenz’s Law and Faraday’s Law of Induction1.

With this definition of the flux being , we can now return to Faraday’sinvestigations. He found that the magnitude of the emf produced depends on therate at which the magnetic flux changes. Faraday found that if the flux throughN loops of wire changes by an amount , during a time delta t, the averageinduced emf during this time isThis fundamental result is known as Faraday’s law of induction. The minus sign is placed there to remind us in which direction theinduced emf acts. Experiment shows that an induced emf always gives rise to acurrent whose magnetic field opposes the original change in flux.

This is knowna Lenz’s law. Let us apply it to the case of relative motion between a magnetand a coil. The changing flux induces an emf, which produces a current in thecoil; and this induced current produces its own magnet field. If the distancebetween the coil and the magnet decreases; so the magnetic field, and thereforethe flux, through the coil increases. The magnetic field of the magnet pointsupward.

To oppose this upward increase, the field produced by the inducedcurrent must point downward. Thus Lenz’s law tells us that the current must moveby the use of the use of the right hand rule. If the flux decreases, so theinduced current produces an upward magnetic field that is “ trying” to maintainthe status quo.

Let us consider what would happen if Lenz’s law were just the reverse. The induced current would produce a flux in the same direction as the originalchange; this greater change in flux would produce an even larger

current, followed by a still larger change in flux, and so on. The current would continueto grow indefinitely, producing power (=) even after the original stimulus ended. This would violate the conservation of energy.

Such “ perpetual – motion” devicesdo not exist. It is important to note, which I believe was forgotten in the classlecture, is that Faraday’s investigation, as summarized in Faraday’s law, saysthat an emf is induced whenever there is a change in flux. Thus an emf can beinduced in two ways: (1) by changing the magnetic field B; or (2) by changingthe area A of the loop or its orientation theta with respect to the field. A motor turns and produces mechanical energy when a current is made toflow in it. You might expect that the armature would accelerate indefinitely asa result of applied torque. However, as the armature of a motor turns, themagnetic flux through the coil changes and an emf is generated. This induced emfacts to oppose the motion (Lenz’s law) and is called the back or counter emf. The greater the speed of the motor, the greater the back emf.

Indeed, as themotor increases in speed, the back emf increases until a balance is reachedwhere the speed remains constant. Thus the counter emf controls the speed of amotor. For a given coil, the ratio of the electromotive force of induction tothe rate of change in the coil is called the self-inductance of the coil.

Analternative definition of self-inductance is the number of flux linkages perunit current. Flux linkage is the product of the flux and the number of turns inthe coil. Self-inductance does not affect a circuit in which the current isunchanging, however, it is of great importance when there is a changing

current, since there is an induced emf during the time that the change takes place. The mutual inductance of two neighboring circuits is defined as theratio of the emf induced in one circuit to the rate of change of current in theother circuit. ()The SI unit of mutual inductance is the henry, the same a the unit ofself- inductance. The same value is obtained for a pair of coils, regardless ofwhich coil is the starting point. ()