Chapter 9

In this chapter, we examine changes to Maxwell's equations that are required for time-varying fields.

9.2 - We begin with Faraday's law and the concept of EMF. I presented an alternative explanation in class of EMF (see Chapter 6 of Electromagnetics by Notaros for more information). Note that the negative sign in Faraday's law is a second law – Lenz's law.

9.3 – When applying Faraday's law, we consider three cases: transformer EMF (stationary contour, field changes); motional EMF (contour changes, field is static); and combined cases (changing contour and time-varying field). Remember that if your thumb (right hand) points in the direction of ds, then your fingers indicate the assumed direction of induced current flow. If you calculate a negative EMF, then the induced current flows in the opposite direction. Lenz's law tells us that the flux associated with the induced current counter-acts the original change in the flux.

9.4 – The second change is Ampere's law. We have to add displacement current, which is related to the time-variation of the electric field.

9.5 – We consider Maxwell's equations for time varying fields, as well as boundary conditions that apply.

9.6 – This section is optional. It provides more details on modifying potentials (V and **A**) to incorporate time delays required for time-varying fields.

9.7 – Phasors are a useful tool, as fields are often time-harmonic. Maxwell's equations in phasor form are derived. Calculating **E** (or **H**) given **H** (or **E**) is demonstrated.

9.8 and 9.9 – Optional but interesting.

Suggested questions

- The summary and review questions are always useful to check your understanding.
- Faraday's law and EMF – 9.1, 9.2, 9.4, 9.6, 9.12
- Displacement current – 9.16, 9.18
- Maxwell's equation – 9.22, 9.26, 9.27, 9.29 (note that the current J is displacement current)
- Time-harmonic fields – 9.39, 9.41, 9.42