Design for EMC – Course Agenda

1. Introduction
   - Electromagnetic Compatibility
   - Approaches to EMC and fundamental concepts
   - Overview of time and frequency domain concepts

   This section begins thorough coverage of the many facets of EMC design. You will learn that the various design techniques presented are derived from a basic set of fundamental principles and the techniques aid each other in achieving compatibility.

2. Non-conducted Coupling
   - Electric and magnetic field coupling
   - The effect of impedance on coupling

   This section examines simple low-frequency models for both capacitive and inductive coupling. In many situations, both types of coupling exist so the ramifications of mixed coupling are explored.

3. Common-Impedance Coupling
   - Grounding
   - Power-supply distribution

   Grounding and power-supply distribution techniques for circuits are discussed in this section. The primary demonstration vehicle will be circuits on PCBs but the concept presented apply in other situations as well. This section includes a detailed discussion of transmission-line models and ground inductance.

4. Radiation from Digital Circuits
   - Radiation from current loops
   - Common-mode radiation and chokes
   - Tools for troubleshooting

   This critically important section deals with the principal mechanisms for radiated emissions from digital circuits, diagnostic techniques and practical ways to minimize emissions. We include a discussion of spectral coherence, spectral effect of ringing, as well as magnetic and electric field probes.

5. Cables
    - Twisted pair, ribbon, and shielded cables
    - Grounding and radiation
    - Diagnosing cable emissions

    Our section on cables illustrates methods for minimizing both electric and magnetic field coupling to and from cables including twisted pairs, ribbon cables, and cables with cylindrical shields.

6. Advanced Cables
    - Ground-loop and common-mode coupling
    - Breaking loops
    - Shielding effectiveness of cables

    This section will define ground-loop coupling and differentiate it from the closely related phenomenon of common-mode coupling. Methods for reducing such coupling will be examined. In addition, the concept of cable transfer impedance will be introduced because this parameter has a major effect on coupling to cables at high frequencies.

7. Conducted Emissions
    - Common and differential-mode interference
    - Topology and mounting of power-line filters
    - Component placement and mounting

    Here we observe the types of conducted emissions and an outline of the design of EMI power-line filters. The ramifications and mounting of a power-line filter are covered because its locations have a significant impact on its effectiveness. In addition, practical fixes for reducing emissions from switching power supplies are given.

8. Susceptibility
    - Radiated and conducted susceptibility
    - Plane-wave coupling to transmission lines
    - Conducted susceptibility

    In this section we discuss ways to increase the immunity of a piece of equipment to external sources of interference. Areas such as parasitic resonance, plane-wave coupling, audio rectification and power-line transient suppression will be discussed.

9. Electrostatic Discharge
    - Humans as ESD sources
    - Direct and indirect coupling of ESD
    - ESD coupling in cables
    - Input protection

    Electrostatic discharge (ESD) is another external phenomenon to electronic equipment is susceptible. This section presents a source model for ESD and discusses ways in which it couples into equipment and associated interconnect cabling.

10. Shielding
    - Basics of electric and magnetic shielding effectiveness
    - Discontinuities in the shield
    - Cabling to shields
    - Shielding low-frequency magnetic fields
    - Measuring shielding effectiveness

    Included in this section are the basic principles of shielding and conceptual models for handling the effect of discontinuities in the shield. Low frequency magnetic fields are particularly difficult to shield against and therefore will receive special attention. We will look at applications of shielding materials, such as gaskets.

11. Diagnostics
    - The use of commonly available tools to diagnose the previously discussed EMI problems.

    Our final section presents ways to characterize, locate, and fix EMI problems from an equipment-level perspective. In doing so, the principal troubleshooting and design techniques of this course will be integrated.