******E.G.S Pillay Engineering College**

**An ISO 9001-2008 Certified Institution**

**Approved by AICTE - New Delhi, Affiliated by Anna University – Chennai**

**Accredited by NAAC with ‘A’ Grade, Accredited by NBA (CSE, EEE & MECH)**

**Nagapattinam – 611002**

**Department of Electronics and Communication Engineering**

Academic Year 2016-2017 - Even Semester

**COURSE PLAN**

COURSE CODE : **EC6011**

COURSE NAME : **Electromagnetic Interference & Compatibility**

SEMESTER : **VII SEM. ECE – A&B SECTIONS** ACADEMIC YEAR : **2016-2017**

COURSE DURATION : **July – December 2016** CLASS ROOM : **SJB104 & SJB 115**

FACULTY DETAILS : **M. Nuthal Srinivasan**

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| **PURPOSE** | To communicate information about Electromagnetic Interference and Compatibility. |
| **PREREQUISITE** | Electrical Engineering and Control Systems |
| **INSTRUCTIONAL OBJECTIVES** | 1. Teach the basics of EMI and EMC. 2. Implant knowledge on the EMI coupling mechanism and its mitigation techniques. 3. Impart comprehensive insight about the current EMC standards and about various measurements techniques. |
| **COURSE OUTCOME(COs)** | After completion of this course, students can able to   1. Identify the EMI Sources. 2. Find EMI problems in PCB level. 3. Discover the subsystem and system level design. 4. Measure emission immunity level from different systems. 5. Plan the Prescribed EMC standard. |

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| Course designed by | | **Anna University, Chennai, Regulation 2008** | | | |
| 1 | Category | GENERAL  (G) | BASIC SCIENCES  (B) | **ENGINEERING SCIENCES**  **AND TECHNICAL ART**  **(E)** | PROFESSIONAL  SUBJECTS  (P) |
|  |  | **X** |  |
| 2 | Broad area | Electronics | Communication & Networking | **Embedded Systems & Signal Processing** | General |
|  |  | **X** |  |
| 3 | Course co-coordinator | | | **Mr. M. Nuthal Srinivasan** | |

**Direct assessment details**

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| **Name of assessment** | **Internal Marks** | **Topics** | **Duration** |
| Unit Test | 20 | Unit I | 2 periods |
| Daily Test 1 | Unit II | 1 period |
| Daily Test 2 | Unit III | 1 period |
| Daily Test 3 | Unit IV | 1 period |
| Cycle Test -1 | II & III Units | 3 Hrs |
| Cycle Test -2 | IV & V Units | 3 Hrs |
| Model Exam | Entire Syllabus | 3 Hrs |
| Assignments |  | Entire Syllabus |  |
| Innovative Assignment | Content Beyond Syllabus |  |
|  |  |  |  |
| Total | 20 |  |  |

**DETAILED LESSON PLAN**

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| **UNIT I: Basic theory:**  Introduction to EMI and EMC, Intra and inter system EMI, Elements of Interference, Sources and Victims of EMI, Conducted and Radiated EMI emission and susceptibility, Case Histories, Radiation hazards to humans, Various issues of EMC, EMC Testing categories, EMC Engineering Application.   |  |  |  | | --- | --- | --- | | **LECTURE** | **TUTORIAL** | **PRACTICAL** | | **8 Hrs.** | **0 Hr** | **0 Hr** | | | | | | | | |
| **Session No** | **Topics to be covered** | **Instruction Delivery** | | | **Testing Method** | **Instructional objective** | **Course Outcome** |
| **Method** | **Teaching Aids** | **Level** |
| 1 | Introduction to EMI and EMC | Lecture with discussion | PPT & Videos | Understand | Tests, Assignments | 1.Teach the basics of EMI and EMC | (CO1) Identify the EMI Sources. |
| 2 | Intra and inter system EMI |
| 3 | Elements of Interference |
| 4 | Sources and Victims of EMI |
| 5 | Conducted and Radiated EMI emission and susceptibility |
| 6 | Case Histories, Radiation hazards to humans, Various issues of EMC |
| 7 | EMC Testing categories |
| 8 | EMC Engineering Application |
| **CUMULATIVE HOURS = LECTURE - 9, TUTORIAL – 0** | | | | | | | |

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| **UNIT II: COUPLING MECHANISM**  Electromagnetic field sources and Coupling paths, coupling via the supply network, Common mode coupling, Differential mode coupling, Impedance coupling, Inductive and Capacitive coupling, Radiative coupling, Ground loop coupling, Cable related emissions and coupling, Transient sources, Automotive transients.   |  |  |  | | --- | --- | --- | | **LECTURE** | **TUTORIAL** | **PRACTICAL** | | **9 Hrs.** | **0 Hr.** | **0 Hr.** | | | | | | | | |
| **Session No** | **Topics to be covered** | **Instruction Delivery** | | | **Testing Method** | **Instructional objective** | **Course Outcome** |
| **Method** | **Teaching Aids** | **Level** |
| **1** | Electromagnetic field sources and Coupling paths | 1.Lecture with discussion  2.Case Studies | PPT & Videos | Understand | Tests,  Assignments | 1.Teach the basics of EMI and EMC | CO2. Find EMI problems in PCB level. |
| **2** | coupling via the supply network |
| **3** | Common mode coupling |
| **4** | Differential mode coupling |
| **5** | Impedance coupling |
| **6** | Inductive and Capacitive coupling |
| **7** | Radiative coupling, Ground loop coupling |
| **8** | Cable related emissions and coupling |
| **9** | Transient sources, Automotive transients |  |  |  |  |  |  |
| **CUMULATIVE HOURS = LECTURE - 18, TUTORIAL – 0** | | | | | | | |
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| **UNIT III: EMI MITIGATION TECHNIQUES**:  Working principle of Shielding and Murphy‟s Law, LF Magnetic shielding, Apertures and shielding effectiveness, Choice of Materials for H, E, and free space fields, Gasketting and sealing, PCB Level shielding, Principle of Grounding, Isolated grounds, Grounding strategies for Large systems, Grounding for mixed signal systems, Filter types and operation, Surge protection devices, Transient protection.   |  |  |  | | --- | --- | --- | | **LECTURE** | **TUTORIAL** | **PRACTICAL** | | **10 Hrs.** | **0 Hr.** | **0 Hr.** | | | | | | | | |
| **Session No** | **Topics to be covered** | **Instruction Delivery** | | | **Testing Method** | **Instructional objective** | **Course Outcome** |
| **Method** | **Teaching Aids** | **Level** |
| **1** | Working principle of Shielding and Murphy‟s Law | Lecture with discussion | PPT & Videos | Understand | Tests,  Assignments | 2. Implant knowledge on the EMI coupling mechanism and its mitigation techniques | (CO3)Discover the subsystem and system level design. |
| **2** | LF Magnetic shielding, Apertures and shielding effectiveness |
| **3** | Choice of Materials for H, E, and free space fields |
| **4** | Gasketting and sealing, PCB Level shielding |
| **5** | Principle of Grounding, Isolated grounds |
| **6** | Grounding strategies for Large systems |
| **7** | Grounding for mixed signal systems |
| 8 | Filter types and operation |
| 9 | Surge protection devices |  |  |  |  |  |  |
| 10 | Transient protection |  |  |  |  |  |  |
| **CUMULATIVE HOURS = LECTURE - 27, TUTORIAL – 0** | | | | | | | |

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| **UNIT IV: STANDARDS AND REGULATION:**  Need for Standards, Generic/General Standards for Residential and Industrial environment, Basic Standards, Product Standards, National and International EMI Standardizing Organizations; IEC, ANSI, FCC, AS/NZS, CISPR, BSI, CENELEC, ACEC. Electro Magnetic Emission and susceptibility standards and specifications, MIL461E Standards   |  |  |  | | --- | --- | --- | | **LECTURE** | **TUTORIAL** | **PRACTICAL** | | **9 Hrs.** | **0 Hr.** | **0 Hr.** | | | | | | | | | |
| **Session No** | **Topics to be covered** | **Instruction Delivery** | | | **Testing Method** | **Instructional objective** | **Course Outcome** | |
| **Method** | **Teaching Aids** | **Level** |
| **1** | Need for Standards, | Lecture with discussion | PPT & Videos | Understand | Tests,  Assignments | 2. Implant knowledge on the EMI coupling mechanism and its mitigation techniques | (CO4)Measure emission immunity level from different systems | |
| **2** | Generic/General Standards for Residential and Industrial environment |
| **3** | Basic Standards, Product Standards |
| 4 | National and International EMI Standardizing Organizations |
| 5 | IEC, ANSI, FCC |
| **6** | AS/NZS, CISPR, BSI |
| **7** | CENELEC, ACEC |
| 8 | Electro Magnetic Emission and susceptibility standards and specifications |
| 9 | MIL461E Standards |  |  |  |  |  |  | |
| **CUMULATIVE HOURS = LECTURE - 36, TUTORIAL – 0** | | | | | | | | |

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| **UNIT V: EMI TEST METHODS AND INSTRUMENTATION**   |  |  |  | | --- | --- | --- | | **LECTURE** | **TUTORIAL** | **PRACTICAL** | | **9 Hrs.** | **0 Hr.** | **0 Hr.** |   Fundamental considerations, EMI Shielding effectiveness tests, Open field test, TEM cell for immunity test, Shielded chamber , Shielded anechoic chamber, EMI test receivers, Spectrum analyzer, EMI test wave simulators, EMI coupling networks, Line impedance stabilization networks, Feed through capacitors, Antennas, Current probes, MIL -STD test methods, Civilian STD test methods. | | | | | | | |
| **Session No** | **Topics to be covered** | **Instruction Delivery** | | | **Testing Method** | **Instructional objective** | **Course Outcome** |
| **Method** | **Teaching Aids** | **Level** |
| **1** | Fundamental considerations | Lecture with discussion | PPT & Videos | Understand | Tests,  Assignments | 3. Impart comprehensive insight about the current EMC standards and about various measurements techniques | 5.Plan the Prescribed EMC standard |
| **2** | EMI Shielding effectiveness tests |
| **3** | Open field test |
| 4 | TEM cell for immunity test |
| 5 | Shielded chamber, Shielded anechoic chamber |
| **6** | EMI test receivers, Spectrum analyzer |
| **7** | EMI test wave simulators, EMI coupling networks |
| 8 | Line impedance stabilization networks, Feed through capacitors |
| 9 | Antennas, Current probes, MIL -STD test methods, Civilian STD test methods |  |  |  |  |  |  |
| **CUMULATIVE HOURS = LECTURE - 45, TUTORIAL – 0** | | | | | | | |

**Text / Reference Books**

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| **Sl. No.** | **Title of the Book** | **Author(s)** | **Publisher** |
| **TEXT BOOKS** | | | |
| T1 | Introduction to Electromagnetic compatibility | Clayton Paul | Wiley Interscience, 2006 |
| **REFERENCES** | | | |
| R1 | Engineering Electromagnetic Compatibility | V. Prasad Kodali | IEEE press, Newyork, 2001. |
| R2 | Electromagnetic Compatibility Engineering | Henry W. Ott | John Wiley & Sons Inc, Newyork, 2009 |
| R3 | EDN‟s Designer‟s Guide to Electromagnetic Compatibility | Daryl Gerke and William Kimmel | Elsevier Science & Technology Books, 2002 |
| **REFERENCE WEBSITES** | | | |
| 1 | <http://nptel.iitm.ac.in/courses/Webcourse-contents> | | |
| 3 | http:// [www.cse.iitd.ernet.in](http://www.cse.iitd.ernet.in) | | |
| 4 | <http://www.books.google> | | |

**GAP ANALYSIS:**

To satisfy the CO 5 (Plan the Prescribed EMC standard.)

I Plan to give **innovative assignments**

**CONTENT BEYOND SYLLUBI:** Assignments forthe following topics:

1. Log periodic antenna for outdoor measurements
2. LMG Test Suite.
3. Review of different companies and their EMI shielding methods.

**COURSE INCHARGE**

**Programme Name: B.E. Electronics and Communication Engineering**

**PROGRAM EDUCATION OBJECTIVES:**

1. Graduates will have the ability of successful technical or professional careers in the electronics and communication engineering and its relative disciplines
2. Graduate will exhibit technical skills to meet the day to day challenges with social consciousness.
3. Graduate will possess lifelong learning ability and teamwork capability

**PROGRAM OUTCOME:**

1. Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialisation for the solution of complex engineering problems.
2. Problem analysis: Identify, formulate, research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for public health and safety, and cultural, societal, and environmental considerations.
4. Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5. Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools, including prediction and modelling to complex engineering activities, with an understanding of the limitations.
6. The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
7. Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9. Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10. Communication: Communicate effectively on complex engineering activities with the engineering community and with t h e society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
11. Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one’s own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
12. Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

**PSO – Program Specific Outcome:**

1. Examine the emerging areas in the field of communication/networking and signal processing
2. Apply the principles of semiconductor devices, Digital systems, Microprocessors in the field of consumer electronics, medical, defense and spacecraft electronic industry
3. Design and analyze subsystems and /or modules as a team for a variety of comparisons and recent applications in Electronics and Communications.
4. Adapt recent developments in the electronics and communication engineering areas along with state of the art Software tools.

**Mapping Table 1: COs of EC6011: Electromagnetic Interference and Compatibility Vs POs**

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| Course Outcomes (COs) | CO  level | Program Outcomes (POs) | | | | | | | | | | | |
| PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
| PO level |  | K3 | K4 | K5 | K5 | K6/k5/k4 |  |  |  |  |  |  |  |
| CO1 | K2 | 2 | - | - | - |  |  |  |  |  |  |  |  |
| CO2 | K2 | 2 | - | - | - |  |  |  |  |  |  |  |  |
| CO3 | K2 | 2 | - | - | - |  |  |  |  |  |  |  |  |
| CO4 | K2 | 2 | - | - | - |  |  |  |  |  |  |  |  |
| CO5 | K3 | 3 | 2 | - | - |  |  |  |  |  |  |  |  |

**Mapping Table 2: COs of EC6011: Electromagnetic Interference and Compatibility Vs PSOs**

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| Course Outcomes (COs) | CO level | Program Specific Outcomes (PSOs) | | | |
| PSO1 | PSO2 | PSO3 | PSO4 |
| PO level |  | K4 | K3 | K4 | K2 |
| CO1 | K2 | - | 2 | 1 | - |
| CO2 | K2 | - | 2 | 1 | - |
| CO3 | K2 | - | 2 | 1 | - |
| CO4 | K2 | - | 2 | 1 | - |
| CO5 | K3 | - | 3 | 2 | - |

**Note: Adequate Support by the COs to POs and PSO\s: 3- High 2- Medium 1- Low**

**K1-Remembering, K2-Understanding, K3-Applying, K4-Analysing, K5-Evaluating, K6-Creating**