K.RAMAKRISHNAN COLLEGE OF TECHNOLOGY
DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING
EC6011 - Electromagnetic Interference and Compatibility
TWO MARKS – QUESTION AND ANSWERS

1. Define EMI

Electromagnetic interference is the degradation in the performance of a device, or equipment, or a system caused by an electromagnetic disturbance.

2. Define EMC

The ability of a receptor (a device, or equipment, or a system) to function satisfactorily in its electromagnetic environment without at the same time introducing intolerable electromagnetic disturbances to any other device/equipment/system in that environment is called electromagnetic compatibility.

3. What are the three criteria for an electromagnetically compatible system to satisfy?

An electromagnetically compatible system satisfies three criteria are

1. It does not interfere with the operations of other systems.
2. It is immune from the emissions of other systems.
3. It does not interfere with its own operation

4. What are the different EMI Sources in Circuits?

- Local oscillators
- Switches
- Motors
- Filters
- Relays
- Circuit breakers
- Logic & Digital circuits

5. What are the three ways to prevent interference?

There are three ways to prevent interference:

- Suppress the emission at its source.
- Make the coupling path as inefficient as possible.
- Make the receptor less susceptible to the emission.

6. What are the various methods to eliminate EMI?

The effective methods to eliminate EMI are:

- Shielding
- Grounding
- Bonding

- Filtering
- Isolation
- Separation and orientation
- Cable design

7. How are EMI/EMC classified?

Radiated emissions and susceptibility (RE and RS) Conducted emissions and susceptibility (CE and CS)

8. Write down the mathematical expression for ESD.

$$A(t) = 1943\ (e^{-t}/2.2 - e^{-t}/2) + 857\ (e^{-t}/22 - e^{-t}/20)$$

9. What are the different EMI Sources in Circuits?

- Local oscillators
- Switches
- Motors
- Filters
- Relays
- Circuit breakers
- Logic & Digital circuits

10. What are the commonly used site antennas for measurement of RE and RS?

- Rod antenna
- Loop antenna
- Biconical antenna
- Dipole antenna
- Log periodic antenna
- Conical log spiral antenna
- Waveguide horn

11. What are the major elements of electromagnetic?

Source (sometimes referred to as an emitter) produces the emission. It may be a noisy component, or a transmitter
Receptor (sometimes referred to as a victim) is a component or device that receives noise or interference from the source
Coupling path transfers the emission energy to a receptor, where it is processed, resulting in either desired or undesired behavior.

12. List out the mechanism of the electromagnetic interference travel from source to receptor

The various mechanisms in which electromagnetic interference can travel from its source to the receptor are:

- Direct radiation from source to receptor

- Direct radiation from source picked up by the electrical power cables or the signal/control cables connected to the receptor, which reaches the receptor via conduction
- Electromagnetic interference radiated by the electrical power, signal, or control cables of the source
- Electromagnetic interference directly conducted from its source to the receptor via common electrical power lines or via signal/control cables

13. What is Electro Static Discharge?

Electrostatic discharge (**ESD**) is the sudden flow of electricity between two electrically charged objects caused by contact, an electrical short, or dielectric breakdown. A buildup of static electricity can be caused by charging or by electrostatic induction.

14. **What are the various types of EMI?**

Radiated Emission (RE) Conducted Emission (CE) Radiated Susceptibility (CE) Conducted Susceptibility (CS)

15. What is RE and RS?

The term **conducted emissions** refers to the mechanism that enables electromagnetic energy to be created in an electronic device and coupled to its AC power cord. Similarly to radiated **emissions**, the allowable **conducted emissions** from electronic devices are controlled by regulatory agencies.

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17. What are the different levels in EMC testing?

- Development test
- Pre-compliance test
- EMC compliance test
- Production test

18. List the various EMI sources

- Equipment noise (Ex. Communication , Radar , Navigation equipment noise)
- Natural noise
- Terrestial noise (Atmospherics, Lightning, ESD)
- Celestial noise (Cosmic and Galactic Noise)
- Circuits and components noise (Local Oscillator, Switches, Motors)

19. What are the different levels in EMC testing?

- Development test
- Pre-compliance test
- EMC compliance test
- Production test

20. What are the types of EMC test?

- Conducted emissions
- Radiated emissions
- Conducted immunity
- Radiated immunity
- ESD immunity
- Transient immunity
- Surge immunity

21. What are the various ways of radiating coupling?

The various ways of radiating coupling are:

Coupling of natural and similar electromagnetic environment to the receptor, such as power line. The power transmission line acts as a receiving antenna. A receptor may also receive electromagnetic noise or interference through exposed connectors (or connections) or from exposed signal lines in the equipment or circuit.

Coupling of electromagnetic energy from nearby equipment, via direct radiation.

22. How interference is coupled through conduction coupling ? Give examples.

The conductive coupling between an emitter and receptor occurs via a direct conduction path between the emitter and receptor.

Examples of such coupling are:

- Interference can be carried by power supply lines when emitter and receptor operate from the same power supply line. For example, common mains power supply is a frequent source of conducted interference.
- Interference can also be carried from emitter to receptor by signal or control lines, which are connected between the two.

22. Define Inductive coupling and capacitive coupling.

The inductive coupling between two loops occurs in low series impedance circuits and at low frequencies.

The capacitive coupling occurs in the presence of high impedance to the ground and is

predominant at high frequencies.

23. Write a short note on natural noise.

Natural noise are classified as

a. Celestial noise

b. Extraterrestrial noise

a. Celestial noise : The celestial bodies like sun, stars, and galaxy are at a very high temperature. The electromagnetic radiation from these bodies can be attributed to the random motion of charged ions from thermal ionization.

b. Extraterrestrial noise : The sources of extraterrestrial emissions have continuous or discrete distribution. Potential sources of discrete emission are the sun, moon, and Jupiter. They emit broadband and narrowband electromagnetic noise. Potential source of continuous emission is galaxy. It emits broadband electromagnetic noise.

24. What are the strong sources of atmospheric noise?

The strong sources of atmospheric noise are

1. Lightning
2. Electrostatic discharge

25. How lightning discharge occur?

Lightning occurs as a result of electric discharge in the atmosphere from charge-bearing cloud. Clouds capture charges from the atmosphere. As the result of the charge accumulation, clouds acquire sufficient high potential with respect to the ground. When the field intensity in a charged cloud exceeds the breakdown level, the result is electric discharge.

26. What are the two forms electric discharge that takes place from lighting discharge?

This electric discharge takes place from

- a cloud to the ground
- one cloud to another.

27. Define electromagnetic pulse .

A nuclear explosion results in the generation of an electromagnetic pulse. Nuclear electromagnetic pulse (NEMP) leads to the generation of electromagnetic interference (EMI).

28. What are the two broad phenomena of EMI generation associated with nuclear explosion?

Two broad phenomena of EMI generation are associated with nuclear explosion

- When equipment or system is located very close to a nuclear burst, the weapon's X-rays or -rays interact with different materials of the system and lead to uncontrolled emission.

- If nuclear explosions takes place in a region where density of air varies with height, an intense pulse of -rays is produced. These -rays travel in all directions. These collide with air molecules and produces fast-moving electrons (recoil electrons) and hence high current. In this case, propagation or radiation of electromagnetic waves can take place.

29. What are the two types of EMI from apparatus and circuits?

Various electrical, electromechanical, and electronic apparatus emit electromagnetic energy in the course of their normal operation. Such emissions may be broadly divided into two categories

1. Intentionally emitted signals
2. Unintentional emission during the operation of an equipment

30. What is meant by intentional radiation?

Intentional EMI sources are those originating from devices whose primary function depends on radiation operation. These sources include Radar, satellite, and communication transmitters.

31. What is meant by unintentional radiation?

Unintentional EMI sources are emitted from devices that transmit radio frequencies, although their primary function is not to radiate energy. Switching power supplies, transmission power cables and electric motors can be considered as sources of unintentional EMI.

32. List the EMI coupling methods

(i) Inductive coupling
(ii) Capacitive coupling
(iii) Radiative coupling
(iv) Conductive coupling

33. What is meant by ground coupled interference?

Electromagnetic interference resulting from an electromagnetic disturbance coupled from one circuit to another through a common earth or ground-return path.

34. What is crosstalk with reference to EMI/EMC design issues?

Coupling of electromagnetic energy from one cable to another in multi-conductor transmission lines results from magnetic field coupling when two cables are located close to each other.

This electromagnetic energy transfer or coupling from one transmission line to another is called **crosstalk**. This is a most common source of electromagnetic interference generation in electrical and electronics circuits.

35. Define – Grounding

Grounding is a technique that provides a low resistance path between electrical or electronic equipment and the earth or common reference low impedance plane to bypass fault current or EMI signal.

36. Why is grounding essential to suppress EMI?

Electrical grounding is essential for the protection of personnel against electric shock, fire threat because of insulation burnout from lightning or electrical short circuit and protection of equipment and systems against electromagnetic interference.

37. How interference is avoided in power supply lines?

The interference is avoided in power supply lines

- By using power line filter.
- Avoid unnecessary switching operations.
- Noisy circuits (with a lot of switching activity) should be physically separated from the rest of the design.
- Harmonic Wave Filters can be used.
- Design for operation at lower signal levels, reducing the energy available for emission.

38. What is a limit on the lower frequency portion of the conducted emission and which is the standard followed during the testing?

- The FCC Part 15 EMC Regulations limit the maximum allowable conducted emission, on the ac power line in the range of 150 KHz to 30 MHz.
- For conducted emissions, standard used for testing are the **LISN** (Line Impedance Stabilisation Network).

39. What is LISN?

LISN means Line Impedance Stabilization Network. A network inserted in the supply mains lead of an apparatus to be tested providing in a given frequency range a specified load impedance for the measurement of disturbance voltages and possibly isolating the apparatus from the supply mains in that frequency range.

40. What are the two main objectives of LISN?

The two main objectives are:

(i) Provide constant impedance over range of frequency.
(ii) Provide pure power without EM noise.

41. What are the four stages involved in EMC test?

The four stages involved in EMC test:

- Development test
- Pre-compliance test
- EMC compliance test
- Production test

42. Mention the various type of EMC test.

The various type of EMC test conducted at the various stages during the development cycle are

- Conducted emissions
- Radiated emissions
- Conducted immunity

- Radiated immunity
- ESD immunity
- Transient immunity
- Surge immunity

EMIC -University Preparation

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.

UNIT II COUPLING MECHANISM

1. Electromagnetic field sources and Coupling paths,
2. Coupling via the supply network,
3. Common mode coupling & Differential mode coupling,
4. **Impedance coupling,**
5. **Inductive and Capacitive coupling,**
6. **Radiative coupling,**
7. **Ground loop coupling,**
8. **Cable related emissions and coupling,**
9. **Transient sources and Automotive transients.**

UNIT III EMI MITIGATION TECHNIQUES

1. Working principle of Shielding and Murphy‟s Law,
2. LF Magnetic shielding,
3. Apertures and shielding effectiveness,
4. Choice of Materials for H, E, and free space fields,
5. **Gasketing and sealing,**
6. **PCB Level shielding,**
7. **Principle of Grounding,**
8. **Isolated grounds,**
9. **Grounding strategies for Large systems & Grounding for mixed signal systems,**
10. **Filter types and operation,**
11. **Surge protection devices & Transient protection.**

UNIT IV STANDARDS AND REGULATION

1. Need for Standards,
2. Generic/General Standards for Residential and Industrial environment,
3. **Basic Standards, Product Standards,**
4. **National and International EMI Standardizing Organizations; IEC, ANSI, FCC, AS/NZS, CISPR, BSI, CENELEC, ACEC.**
5. **Electro Magnetic Emission and susceptibility standards and specifications, MIL461E Standards.**

UNIT V EMI TEST METHODS AND INSTRUMENTATION

1. **Fundamental considerations, EMI Shielding effectiveness tests,**
2. **Open field test, TEM cell for immunity test,**
3. **Shielded chamber , Shielded anechoic chamber,**
4. **EMI test receivers,**
5. **Spectrum analyzer,**
6. **EMI test wave simulators,**
7. **EMI coupling networks,**
8. **Line impedance stabilization networks,**
9. Feed through capacitors,
10. Antennas,
11. Current probes,
12. MIL -STD test methods, Civilian STD test methods.

Important 2 Marks

***Unit* I**

1. EMC & EMI, ESD & EMP
2. Types of EMI -inter & intra
3. Components of EMI -source, victim & coupling paths
4. Effects of EMI
5. Criteria for EMC
6. Source and victims of EMI
7. Various types of coupling- conductive, radiative, inductive and Magnetic
8. Transient suppression
9. Parameters for the measurement of EMI
10. Electromagnetic susceptibility
11. Radiation hazard to humans
12. Aspects of EMC problem
13. Important accepts of the EMC design in Engineering
14. Immunity & Immunity margin
15. Transients &suppression
16. Testing strategies for EMC
17. Types of electromagnetic emission
18. Radiated, conducted - emission and immunity
19. Elements of interference.

Unit II

1. Types of EMI coupling - radiated, conducted, inductive and capacitive
2. Factor influencing grounding schemes
3. Interference, edge rate
4. Transient interference
5. Cross talk and prevent cross talk
6. Pigtail effect
7. Transient coupling
8. Coupling
9. LISN
10. Ground coupled interference
11. Ground looping
12. ESD and EMP
13. Drawbacks of coupling mechanism
14. Factors influence grounding scheme

Unit III

1. Shielding and its needs
2. Difference between various types of shielding
3. Shielding effectiveness and its measurement
4. Purpose of aperture of shielding
5. Advantage of multipoint grounding
6. EMC gaskets, zoning
7. Principle of earth resistance measurement.
8. PCB trace impedance with respect to EMI
9. Transient suppression and surge suppression devices - advantage and disadvantage
10. Filtering –types, insertion loss, parameters describe the performance of filter.
11. Bulging capacitor
12. Objective of signal grounding
13. Types of LPF & its circuit
14. How cable routing is avoided
15. Modes of operation of PI filter
16. Opto isolator

Unit IV

1. Standard and its needs
2. Classification of standard
3. Standard corresponding to industrial needs
4. Basic, generic and product standard and its examples
5. International and national EMI standard organization
6. Difference between the civilian and military standard
7. Advantages of EMC standard
8. Class A devices with respect to FCC
9. Possible errors with respect o EMI testing
10. List the parameters that involves in testing and evaluation of EMI and EMC
11. List the objectives of EMI standards

Unit V

1. Shielding effectiveness and its calculation and its various test methods
2. Attenuation and shielding effectiveness
3. Advantages and precautions for OAT
4. Site and normalized site attenuation
5. Measurement error & factors in OATS
6. Anechoic chamber and TEM – sources of accuracies
7. EMI receiver
8. Spectrum Analyzer
9. LISN -need and purpose
10. Feed through capacitor
11. Current probe
12. Various antenna in EMI measurement
13. Why shielding problem is difficult to handle