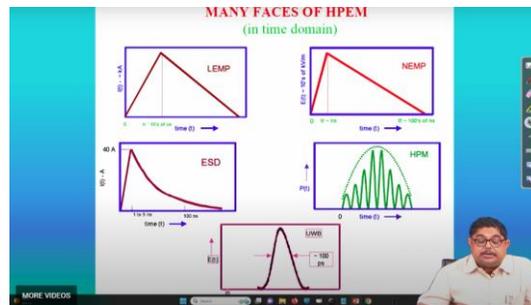


Course name: EMI /EMC and Signal Integrity: Principles, Techniques and Applications.
 Professor name: Prof. Amitabha Bhattacharya
 Department name: Electronics and Electrical Communication Engineering
 Institute name: IIT Kharagpur
 Week :01
 Lecture 2: Introduction to Electromagnetic Compatibility

Welcome to the second lecture of the course on EMI EMC and Signal Integrity. In the last lecture we were discussing the various electromagnetic energy sources that come to our environment. So, we ended with high power electromagnetics in that we have seen lightning, NEMP, ESD, HPM, UWB this is the time domain picture.



Now, in frequency domain you can see that this HPM things HPM systems they cannot be classified like our conventional narrow band wide band sort of system they have a different classification. So, if you have a narrow band that is in high power microwave terminology called hypo band. Hypo band means here you see that as you have seen in the time domain things that all the high power microwaves are not like our normal sinusoidal thing.

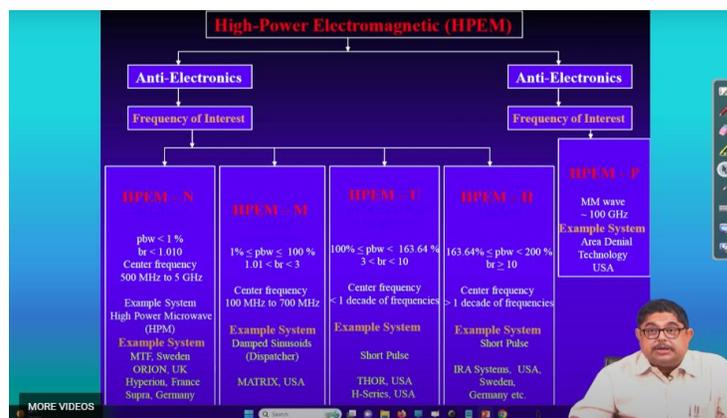
HPEM RADIATING & CONDUCTING ENVIRONMENTS

- Conventional Environments
 - Narrowband
 - Wideband
- IEMI classification based on bandwidth

Band Type	Percent Bandwidth	Bandwidth Ratio
	$pbw = 200 \left(\frac{br - 1}{br + 1} \right) (\%)$	$br = \left(\frac{f_h}{f_l} \right)$
Hypoband ~ Narrow	$pbw \leq 1 \%$	$br \leq 1.01$
Mesoband ~ Moderate	$1 \% < pbw \leq 100 \%$	$1.01 < br \leq 3$
Sub-hyperband ~ Ultra Moderate	$100 \% < pbw \leq 163.64\%$	$3 < br \leq 10$
Hyperband	$163.4 \% < pbw < 200 \%$	$br > 10$

So, they are their bandwidth is definition is different it is not our conventional bandwidth definition that $f\Delta$ by f_r etcetera. So, here that is why they are defined by bandwidth ratio bandwidth ratio is the highest frequency up to which the time domain waveform or frequency domain waveform exist divided by f_i .

So, if and percentage bandwidth is $= 200 \times [(br-1)/(br+1)]$. So, if percentage bandwidth is less than 1 percent that is called a hypo band system, if percentage bandwidth is between 1 percent to 100 percent then they are called meso band system from 100 percent to 163.4 percent they are called ultra moderate or sub hyper band system and hyper band means 163.4 to 200 percent percentage bandwidth. So, a high power microwave system can have highest bandwidth up to 200 percent. So, their band ratio is greater than 10. So, let us see some systems of these people various countries have made this type of systems. So, one is narrow band HPEMN.



So, as we said that percentage bandwidth is less than 1, centre frequency is 500 megahertz to 5 gigahertz. The example is in Sweden there is a system called MTF, in UK there is a Orion system, in France they have Hyperion system, in Germany they have Supra. So, all these are this narrow band HPEMN they can produce huge power. Similarly, the meso band system where it is 1 to 100 percent they are matrix USA. So, their waveform is damped sinusoids actually it is very difficult to produce pure sinusoids at very high frequency. So, then ultra or the sub hyper band system HPEMU. So, example it is a very short pulse. So, one of them is Thor USA, then USA has H series and the hyper band system that is very short pulse those are IRA systems, IRA stands for impulse radiating antenna. Actually, antenna cannot general antennas cannot produce impulse because producing impulse you know this is very difficult, but people have come across that how almost like an impulse very near to impulse the systems are done the antenna is made for that that so that it can radiate an impulse. So, one of that is IRA systems USA it was made for US air force by people like Karl Baum, TV Geary etcetera and their Sweden, Germany they have these systems and then there are millimeter wave systems as I said that area denial technology that you need to disperse the crowd.

So, this HPEMU things are there now all of these are anti electronics. So, if you want to destroy your opponent's electronics you can use this sometimes destroy sometimes non to make it nonfunctional for some time. So, that suppose you enemy has a radar you

want to make it nonfunctional and in that time you will make bombing etcetera. So, these high power systems are made for that.

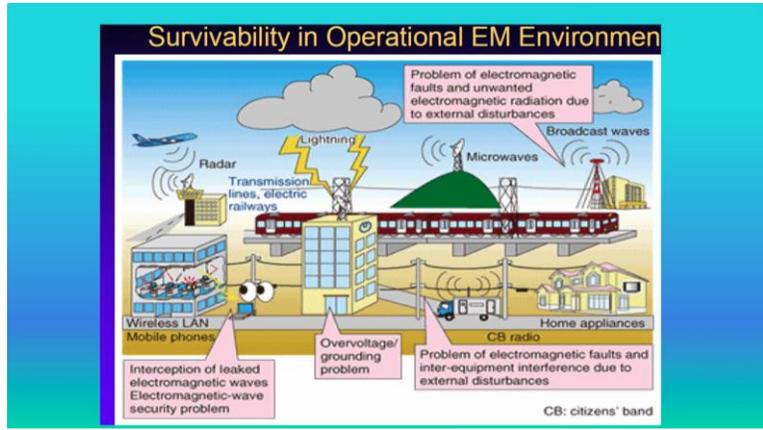


Now, with all those things that we have so much things low power, high power, low frequency, high frequency, low energy, high energy electromagnetic wave in our environment.

But as a human we will have to survive there. So, that is the challenge because you cannot eliminate these environments these are given to you either by nature or by man during its civilization has made these you cannot go away from it. So, you will have to survive here.



Not only you your family will have to survive your children will have to survive. So, you see that even if it is not so what type thing, but in a civilian thing also there are satellite phones, there are Wi-Fi's, there are TVs, there are calculators, there are dish antennas etcetera you will have to survive there.



So, all that needs the knowledge of EMI, EMC that is why this course. You see this is a what type thing you have EMP, you have ordinances high energy etcetera etcetera.



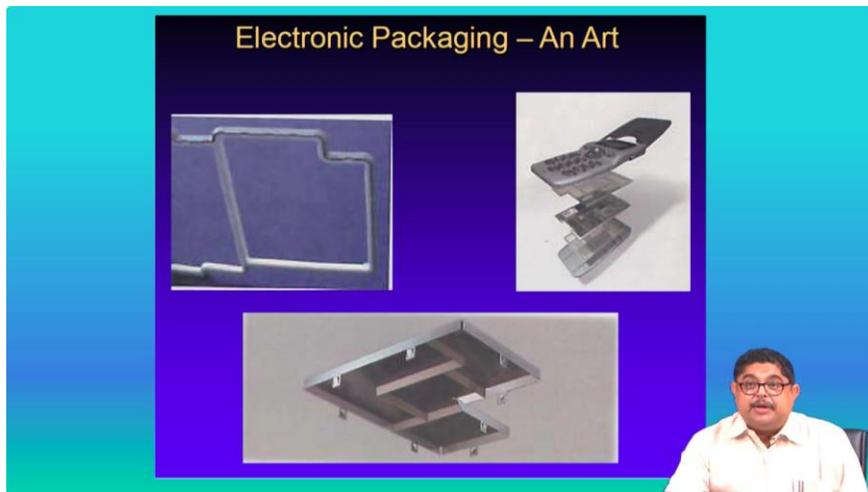
So, P static is there, lightning is there, background EMI is there. So, how you survive?



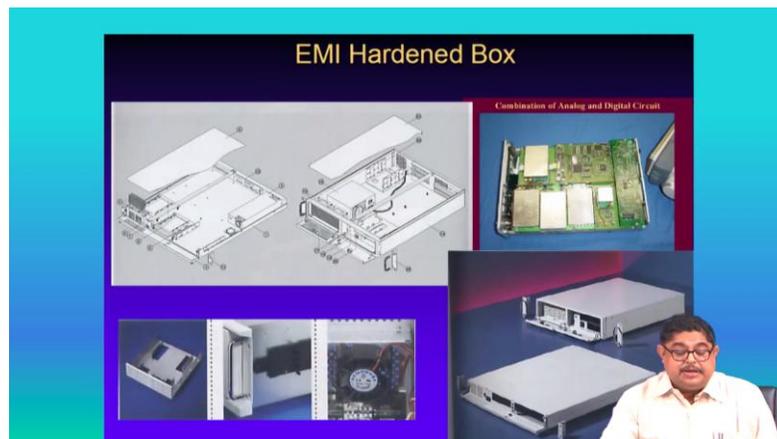
So, ensuring EMC compliance for safety you see that you have you will have to design boards, radar and everything you know now have IC's in them. So, that IC many times that fails due to this electromagnetic environment emitted electromagnetic wave from outside.

So, you know you will have to know this how to make it compatible to this environment. With technological evaluation EMC compliance is becoming more and more difficult because you are having a high integration of various components. So, amongst them there will be various coupling, various mutual effects at high frequency that becomes more and more. So, you will have to also obviously inter system interference that suppose nowadays in your automobile you have various computers, various brake systems, various ignition systems. Now, they also should not have electromagnetic interference among themselves.

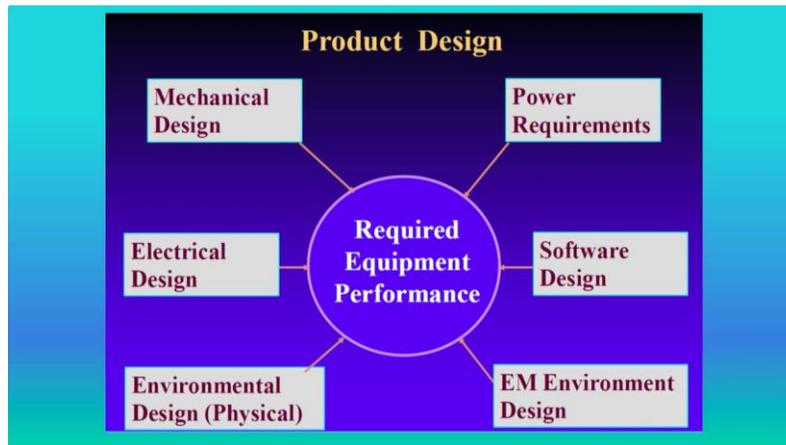
So, you will need to know how to package your electronics that is more of an art some people master it and they are very good EMC engineers.



So, ultimately you will have to make your packaged electronics hardened for EMI.



So, when you design product design you see that there will be mechanical designs obviously, electrical designs, power requirements, software design required. So, that you get the required equipment performance, but with that you need environmental design physical and for us most important E M environment design.



Without these you are not guaranteed that your thing will work even if it works in your laboratory it may not work in the actual environment. So, you need to know this how to design for EMC that will be the subject of this course. So, let us see that if in the design this was not taken care of this EMC design what type of things may happen. These are I will now go through some of the case histories there are lot lot of those case histories during Vietnam war, US's forestal, US jet aircraft carrier they are all these the causes were found out later by investigation that EMI triggered aircraft rocket detonator about US aircraft carrier forestal flight deck. So, rocket detonator was fired, fire took place. So, since it was a aircraft carrier 32 aircrafts were lost by that simple EMI problem 134 people died obviously, some million dollar were lost.

Major Incidents Happened World Wide

➤ Vietnam War (July 29, 1967)

EMI triggered aircraft rocket detonator aboard US Aircraft Carrier FORRESTAL Flight Deck

Forrestal-First US Jet Aircraft Carrier

The image shows a slide titled 'Major Incidents Happened World Wide' with a sub-heading 'Vietnam War (July 29, 1967)'. On the left, text describes an EMI incident on the USS Forrestal. On the right, there is a photo of the carrier and a small inset photo of a man.

Fire Fighting on the Forrestal



- 32 aircrafts lost
- 134 casualties
- \$172 million loss

Falkland war the British ship Sheffield had the most sophisticated anti missile defense system available. Despite that fact during the Falklands war between England and Argentina it was hit by an exocet missile and sank with heavy casualties. It was possible because the anti missile system created electromagnetic interference to radio communication system of Sheffield's Harrier jet contingent.

Falkland War (1982 UK Lost a Destroyer)

Sheffield Catastrophe

- The British Ship *Sheffield* had the most sophisticated antimissile defence system available. Despite that fact, during the Falklands War (1982), it was hit by an Exocet missile and sank with heavy casualties. It was possible because the antimissile system created electromagnetic interference to radio communication system of Sheffield's *Harrier* jet contingent assigned to the ship. While the *Harriers* took off and landed, the missile defence was disengaged to allow communications with the jets. This provided a 'window of opportunity' for the Exocet missile.

— (Source: NASA Reference Publication 1374 July 1995)

Contd.

So, that is why while the Harriers took off and landed the missile defense was disengaged to allow communications with the jet this provided a window of opportunity for the missile.

US army attack helicopter Black Hawk between 1981 and 87 five Black Hawk army helicopters crashed and killed or injured all on board when flew to near radio broadcast transmitters.

US Army Attack Helicopter - UH 60 (*Black Hawk*)

- Between 1981 and 1987, five *Blackhawk* army helicopters crashed and killed or injured all on board when flew too near radio broadcast transmitters.
- Susceptible to EM emissions, evidence revealed that the crashes of Bird caused by flying close to Tx of Radar, Radio, & CB. Electronically Controlled Flight Control System (ECFCS) susceptible to EME

Events in Inter System Aircraft EMI

- Black Hawk vs. Carrier HIRF=9 Killed



Susceptible to EMA missions evidence revealed that the crashes of bird caused by flying close to transmitter of radar radio etcetera. So, radio transmitters if the Black Hawk when the Black Hawk went very near to it was crashed. You see in our country the MiG aircraft that crashes often. Now in our country the investigation after the incident is not so in depth that is why we do not know whether EMA etcetera are involved there, but in USA etcetera they do that investigation and come up with these. So, they harden their systems against that.

Black Hawk crashes
tornado fighter case.

Blackhawk Crashes



- Cause: insufficient immunity of flight (on-board) control electronic sub-system against high intensity radiated fields (HIRF) that produced uncommanded movements while flying past radio broadcast towers.

(Source: NASA Reference Publication 1374 July 1995)

Tornado Fighter Case

- Another case occurred in 1984 near Holzkirchen near Munich, Germany. A West German *Tornado* fighter crashed after flying too close to a powerful Voice of America transmitter.

Events in Inter System Aircraft EMI

- Tornado vs. "Voice of America" Broadcast in Germany
2 pilots killed



HF Radar

(Source: NASA Reference Publication 1374 July 1995)

US German tornado fighter crashed after flying too close to a powerful radio broadcast transmitter. Two pilots got killed, F-16 flight controls, B-55, B-52 it is a very good aircraft very sophisticated fly by air system, but uncommanded activation of rear file control surfaces was experienced when the HF radio was activated on the board.

B-52 Stability Case



- When electronic flight-control systems were first added to the B-52 bomber autopilot system, un-commanded activation of rear flight control surfaces was experienced when the HF radio was activated on the board
- Cause: spurious HF radio signals induced in the wiring system.

— (Source: NASA Reference Publication 1374, July 1995)



F-16 Flight Controls

- An F-16 fighter jet crashed in the vicinity of a Voice of America (VOA) radio transmitter because its fly-by-wire flight control system was susceptible to the radio waves transmitted. Since the F-16 is inherently unstable, the pilot must rely on the flight computer to fly the aircraft. Subsequently, many of the F-16's were modified to prevent this type EMI, caused by inadequate military specifications on that particular electronics system. This F-16 case history was one of the drivers for institution by the Federal Aviation Administration (FAA) of the certification programs.

(Source: NASA Reference Publication 1374 July 1995)

Unintended missile launch, you do not want a missile to be fired, but that time a missile got fired. Pioneer crash I am not going to all if you want I can.

Unintended Missile Launch

- During a B-52 missile interface unit test, an uncommanded missile launch signal took place. One of the contributing factors was crosstalk in the systems wiring. The outcome was a yearlong redesign and test effort.

— (Source: NASA Reference Publication 1374, July 1995)



Pioneer Crash

- Pioneer is the name of a remotely piloted vehicle (RPV) using a portable remote control box. During its flight tests performed by the US Navy in January 1987 aboard the U.S.S. Iowa, the pilot experienced a series of uncommanded manoeuvres that caused loss of control and a crash landing. Subsequent investigation found that the remote control boxes received false signals from HF communication transmitting antennas located aboard the Iowa due to inadequate shielding and cable termination.

— (Source: NASA Reference Publication 1374, July 1995)



Aircraft Passenger Carry-On Devices

- Passenger carry-on devices provide a separate group of case histories. They show the susceptibility of modern electronic systems aboard aircraft to EMI from seemingly innocuous electronic devices, such as portable computers, AM-FM 'walkman' cassette players, dictaphones, radios, heart monitors, and cellular phones.
- NASA maintains a database (ASRS - Aviation Safety Reporting System) - a compilation of voluntary reports detailing safety problems submitted by pilots. These reports are, for the most part, anonymous with non-specific aircraft models and unidentified operating companies.
- During the period 1986 - 1995, the database registered an average 5200 reports a year.

(Source: NASA Reference Publication 1374, July 1996)

Then you know all these that when you go on any flight any aircraft flight the advisory is that please while taking off and taking on that please put all your electronic equipments in switch off mode of aircraft mode flight mode. So, NASA maintains a database a compilation of voluntary reports detailing safety problems submitted by pilots. During the period 1986 to 1995 the database registered in average 5200 reports a year. So, these were all civilian cases that the various the pilots what difficulty they faced due to the various electronic gadgets that was taken by or used by the passengers. But in many cases people do not understand that the equipment performance their degradation etcetera is due to EMI. So, then they do not report it as an EMI problem that is why the actual cases are much much more.

- Publicity was given to electronic pacemakers, or aircraft and air traffic navigational control systems, but it is only a 'tip of iceberg'.
- It was pointed out by many researchers that users experiencing equipment performance degradation often do not suspect EMI as a cause, and thus a number of EMI problems are never registered.

Accident at Foundry Plant



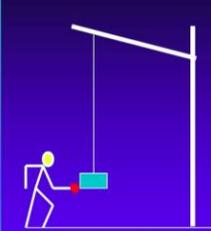
The diagram shows a stick figure worker on the ground. Above him is a radio-controlled overhead transporter (a crane) with a hook and a bucket. A red lightning bolt symbol indicates a signal or error. The transporter is tilted, suggesting it is about to dump its load.

- A foundry worker died when the radio-controlled overhead transporter thought out a few tons of liquid metal on him.
- Cause: an accidental signal from a radio transmitter was interpreted by the automatic system as the legitimate order to get rid of the load.

You see accident on a foundry plant, a foundry worker died when the radio controlled overhead transporter thought out this is pour out a few tons of liquid metal on him. You

see that cause was an accidental signal from a radio transmitter was interpreted by the automatic system as the legitimate order to get rid of the load. So, you see the effect of EMI very very severe sometimes it become .

Burning Crane



- A building worker was burned when touching the load of a crane installed for building operations.
- Cause: an electric arc due to the RF current induced in the metallic structure by a nearby broadcasting transmitter



burning crane a building worker was burned when touching the load of a crane cause was an electric arc due to the RF current induced in the metallic structure by a nearby broadcasting transmitter.

You all know ABS antilock braking systems in car nowadays it is mandatory, but sometimes in earlier days they were not functioning and the accident etcetera severe accident took place.

Antilock Braking Systems (ABS) Failure



- Early ABS on both aircraft and automobiles were susceptible to EMI.
- Accidents occurred when the brakes functioned improperly because EMI disrupted the ABS control system.



Antilock Braking Systems (ABS)



- During the early years of ABS, some automobiles equipped with ABS had severe braking problems along a certain stretch of the German autobahn. The brakes were affected by near-by radio transmitters. The near term solution was to erect a mesh screen along the roadway to attenuate the EM field strength.

(Source: NASA Reference Publication 78-117, July 1995)



EMI disrupted the ABS control system many many cases were there. Antilock braking systems during the early years some automobiles equipped ABS has severe braking problems. Actually in a stretch of the German highway where many automobiles get tested because it is a very good highway for testing all those things you can run at a top speed. The brakes were affected by nearby radio transmitter. Now when there was a screen put over that radio transmitter zone the problem went away.

Runaway Wheelchairs



- Some powered - wheelchairs experienced erratic, unintentional movements when police, fire, or CB transmitters were activated nearby.
- These movements included sudden starts that caused wheelchairs to drive off curbs or piers. Although no fatal injuries have been reported, FDA has ordered manufacturers of motorized wheelchairs to shield them from EMI and to educate users on the potential EMI hazards.

So, then wheelchairs sometimes powered wheelchairs experienced erratic unintentional movements when police fire or cv transmitters were activated nearby. This movement included sudden starts that caused wheelchairs to drive off curves or fires. So, this is a thing that if patients are disabled they get this type of things it is a severe problem that is why the manufacturers were later asked to harden their things from EMI.

"Black hole" in railway system



- An automatic registration system of rail wagons passing checkpoints indicated that wagons enter into some region, but never go out of it; it was as a black hole were there.
- Cause: radiation from a high-power radar station newly-constructed near the checkpoint burned out electronic components installed on the wagons.

- Source: private communication from a NTIA source)

A black hole in railway system that in railways in there are some zones where they count how many wagons are there. Now wagons enter into some region, but never go out of it.

It was as if a black hole were there radiation from a high power radar station newly constructed near the checkpoint burned out electronic component installed on the wagons.

Ambulance Heart Monitor



- Susceptibility of medical equipment to conducted or radiated emission is a concern.

Case: a heart attack victim was being taken to the hospital with a monitor/defibrillator attached to the patient. But, every time the personnel turned on the radio to request medical advice, the machine shut down and the patient died.

Cause: the combination of insufficient immunity of monitor/defibrillator and excessive RF field strength from the radio (the ambulance roof had been changed from metal to fibreglass). (Source: NASA Reference Publication 1374 July 1995)

Ambulance heart monitor, a heart attack victim was being taken to the hospital with a monitor defibrillator, but every time the personnel turned on the radio to request medical advice the machine shut down and ultimately the patient died. Cause was the combination of insufficient immunity of monitor defibrillator and excessive RF field strength from the radio. The ambulance roof had been changed from metal to fibreglass to make it a, but that actually remove the shield that is why this problem came this is self explanatory. Hearing aids a particular hearing aid people those aged people they were had to the hearing aid malfunction and they had to endure huge huge disable of rock music.

Hearing Aids

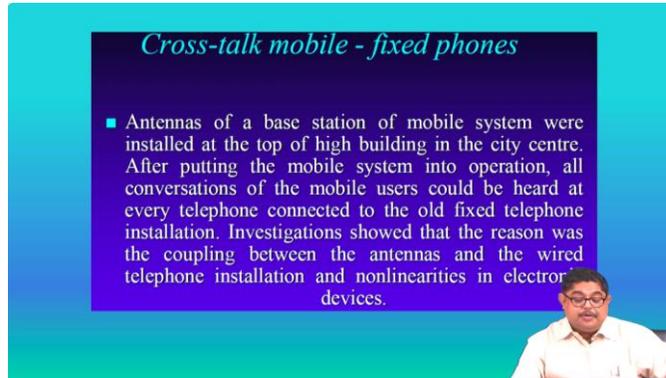
- Millions of pensioners using a hearing-aid device were forced to endure 24-hour rap and rock music from the 41 powerful radio transmitters of 'Ailing Radio 1' network in the UK. It was caused by a flaw in the device that acted as unintended radio receiver, in addition to its intended function.

—(Source: Europa Times No.22, March 1996)



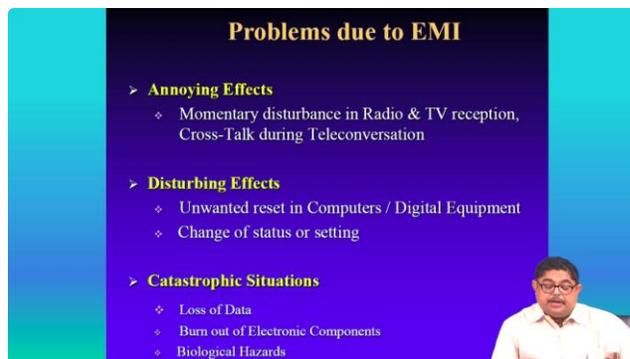
Sometimes the problems due to EMI give rise to annoying effects like this all of you have experience that if suppose a you are watching a radio or TV was or listening to a TV and suddenly if someone ignites a or starts a scooter or some teleconversation goes you see that there is a disturbance picture moves etcetera. So, that is annoying disturbing effects unwanted reset in computers digital equipment, catastrophic situations, loss of data burn out of electronic components, biological hazards etcetera. So, that was our

introduction to our electronic environment. Now, we will start with that how to tackle or how to mitigate or you have now understood that EMI is a severe problem. So, we should put sufficient or we should master sufficient art to mitigate that that will start now.



Cross-talk mobile - fixed phones

- Antennas of a base station of mobile system were installed at the top of high building in the city centre. After putting the mobile system into operation, all conversations of the mobile users could be heard at every telephone connected to the old fixed telephone installation. Investigations showed that the reason was the coupling between the antennas and the wired telephone installation and nonlinearities in electronic devices.



Problems due to EMI

- **Annoying Effects**
 - ◇ Momentary disturbance in Radio & TV reception, Cross-Talk during Teleconversation
- **Disturbing Effects**
 - ◇ Unwanted reset in Computers / Digital Equipment
 - ◇ Change of status or setting
- **Catastrophic Situations**
 - ◇ Loss of Data
 - ◇ Burn out of Electronic Components
 - ◇ Biological Hazards

Now, before we attack any problem first we engineers who want to solve some problem we first want a model of the problem unless and until we have an engineering model we cannot attack the problem or solve the problem that is why we start with this principles of electromagnetic compatibility.

PRINCIPLES OF ELECTROMAGNETIC COMPATIBILITY



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So, let us see what is the definition of EMI and EMC we have seen the environment, but there we use these terms EMI, EMI compatible, EMI compatible, but what is it? So, what is EMI? EMI is impairment of the performance of an electronic system or subsystem by an unwanted electromagnetic signal. You see that an electromagnetic system should perform. Now, it is designed for that, but if that performance get impaired by an unwanted electromagnetic signal then we call that there is an interference. It is not noise ,it is interference because some other signal is interfering with its performance.

It is not noise please understand that that interference is a different thing from noise some other electromagnetic signal which is useful for someone, but it may not be useful to me that is why I am calling that unwanted electromagnetic thing to be interference. It is unwanted to me it is an electromagnetic signal it is a signal it is a noise there is a distinct difference between signal and noise. Signal is deterministic thing it is required for someone not for me, but noise it is an undeterministic thing ,it is a random thing. So, this electromagnetic interference is not random etcetera that is why it can be modeled because it is deterministic. So, we will try to do that.

Then what is electromagnetic compatibility?

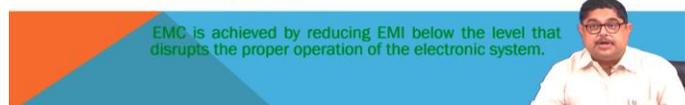
WHAT IS EMI & EMC?

Electromagnetic Interference (EMI)

is the impairment of the performance of an electronic system or subsystem by an unwanted electromagnetic signal

Electromagnetic Compatibility (EMC)

is the ability of an electronic system or subsystem to reliably operate in its intended electromagnetic environment without either responding to unwanted electromagnetic signal or generating unwanted electromagnetic signal



It is the ability of an electronic system or subsystem to reliably operate in its intended electromagnetic environment. It is the ability of an electronic system or subsystem to reliably operate in its intended electromagnetic environment without either responding to unwanted electromagnetic signal or generating unwanted electromagnetic signal. It should not generate unwanted signals for others it should not get disturbed by unwanted signal coming from others. And by these two it should make itself able to perform its intended performance simple. So, EMC is achieved this compatibility is achieved by reducing EMI below the level that disrupts the proper operation of the electronic system.

So, we are not saying that we will be able to eliminate EMI, but we will reduce it to a level so that we can carry on our intended operation. It is like suppose you have some

medical problem let us say that I have some blood sugar. Now, it is not that by taking medicine or by taking some other therapy I will be able to remove blood sugar problem, but it will be kept within a level so that I can do my other activities my normal life I can lead. So, that is the role of EMC.

A system is electromagnetically compatible if it satisfies three criteria :

1. *It does not cause interference with other systems.*
2. *It is not susceptible to emissions from other systems.*
3. *It does not cause interference with itself.*

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Now, so we will say that a system is electromagnetically compatible if it satisfies three criteria.

The first one is it does not as I said that it does not produce unwanted signal for others that is the first point it does not cause interference with other systems. So, it should not be a culprit to others. Then the second point is even if others are culprits it should not be susceptible to them that is why it is not susceptible to emissions from other system. Again susceptible means it should try to reduce those emitted unwanted signals by others to a level so that it can perform. And also this is third point is an interesting point it does not cause interference with itself why because we are talking of a system now system has various subsystems now they may cause an interference among them.

So, it does not cause interference with itself. So, suppose it emits some unwanted signal and that miss that stops the intended behavior of a subsystem that will come under this third point.

EMC is concerned with the i)generation, ii)transmission and iii) reception of electromagnetic energy.

- A *source* (also referred to as an *emitter*) produces the emission.
- A *transfer* or *coupling path* transfers the emission energy to a *receptor* (*receiver*), where it is processed, resulting in either desired or undesired behavior.
- Interference occurs if the received energy causes the receptor to behave in an undesired manner.*

Unintentional transmission or reception of electromagnetic energy is not necessarily detrimental; undesired behavior of the receptor constitutes interference.



So, EMC is concerned with the generation transmission and reception of electromagnetic energy who generates is called source. Now, in EMC parlance EMC engineers call it an emitter a source produces the emission or an emitter produces the emission. Then transmission of electromagnetic energy in other cases we in electromagnetics we call it transmission line, wave guides etcetera etcetera. But here generally we call it the transfer path or coupling path these are all terminologies of EMC engineers. Transfers the emission energy emitted energy to a receptor where it is processed resulting in either desired or undesired behavior. And obviously, receptor is a source of energy the one where the this transferred energy is received. Interference occurs if the received energy causes the receptor to behave in an undesired manner. Unintentional transmission or reception of electromagnetic energy is not necessarily detrimental undesired behavior of the receptor constitutes interference self explanatory.

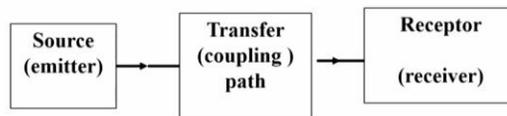


FIGURE 1. Basic decomposition of the EMC coupling problem.



Now, we come to the model. So, we can say that the whole EMC coupling problem can be brought like this that source or emitter transfer path or coupling path and receptor receiver. So, this is in all cases true in EMC we are just adding the emitter and emitter to the EMC we are just adding the terms emitter coupling path and receiver. So, how to prevent interference you can say first suppress the emission at its source, but you cannot do it fully because that source is also having intended signal, unintended signal you can try to suppress. Then make the coupling path as inefficient as possible this is for unintended signal and make the receptor less susceptible to the emission.

Now, the next part the transfer of electromagnetic energy we can say that the transfer of electromagnetic energy with regard to the prevention of interference can now be subdivided into four subgroups that subgroups are shown here.

There are three ways to prevent interference :

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

The transfer of electromagnetic energy (with regard to the prevention of interference) can be subdivided into four subgroups:

- 1) Radiated emissions
- 22) Radiated susceptibility
- 33) Conducted emissions
- 44) Conducted susceptibility

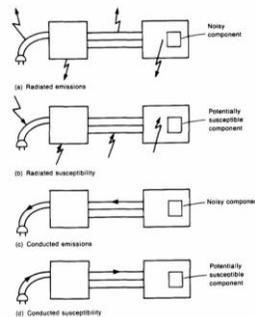


FIG.2 The four basic EMC sub problems:
 (a) radiated emissions;
 (b) radiated susceptibility;
 (c) conducted emissions;
 (d) conducted susceptibility.



You see these are any model means you are trying to break the actual problem into various small problems which you can handle. So, the first one is called radiated emission you see actually any system that radiates also it receives, but for analysis say we are breaking it as if it is only radiating the first part radiated emission. So, it is from all the paths you see from the transfer path from the source from the receptor it is radiating that means it is giving to free space. The second part is radiative susceptibility there is no emissions is taking place. The second place is that it is only receiving. So, from the environment the transfer paths are receiving radiation the source is receiving radiation the receptor is receiving radiation then conducted emission you see here there are no radiation, but the system is through the transfer path it is sending emissions and the approach is to send the emission. The fourth category is it is again there is no radiation only conducted electromagnetic energy transfer, but it is taking it from outside environment that is why the arrows are different in c and d. Similarly, in a and b the arrows directions are different. So, conducted susceptibility actually we will throughout this course as long as we will develop this model we will be developing on the basis of these four sub problems then we will put it together. So, there will be radiated emission

there will be radiated susceptibility there will be conducted emission there will be conducted susceptibility sub problems. When we will do radiated emission we do not consider the energy coming from outside we do not consider the energy that is getting conducted to it outside that is getting also we do not consider the energy that is being conducted from the system to outside. So, we will be that time only consider that it is radiating itself it is a radiator like an antenna type of thing. So, every part is radiating. So, we will try to have an idea what will be the that emission and then in the second part we will say that ok if that type of radiation comes what is the maximum of that type of radiation can come. Then whether that is enough for me to operate or I will have to reduce it what are the ways by which I can reduce it. Similarly, for conducted emission that I am sending this much conducted energy out. So, is it permissible is will others be able to operate their operation if it is done and the last part is if others are sending it through the conducted part. Conducted means through some transfer line that is connecting me not through free space radiation it is some through some line if it is those energy coming to me will I be able to still operate with for my intended operation or I will have to have some means to reduce that ok. So, I end it here today we will start next day from this that what is our basic models and we will see some more things from the next day. Thank you.