myself punya murthy from department of chemistry iit guwahati i welcome you all to iit paul program in this class we will study about hydrocarbons hydrocarbons are the compounds that contain only carbon and hydrogen atoms examples methane ethane propane and
So on you can go on butane you can have if you look at this compound it has only one carbon is bonded with four hydrogen atoms here you have two carbon atom and they are bonded together and also in addition to that each carbon is bonded with three hydrogen atoms this is called ethane and if you have three carbon atoms is called propane and 4 is called butane you can go on like this
So they play they are important source of energy you must be familiar with lbg cng petrol diesel polythene bag paint drug and
So on if you look at lbg is abbreviated form of liquid petroleum gas we use as fuel uh in uh home and cng's compressed natural gas and petrol diesel they are obtained by a fractional distillation from petroleum that is obtained from earth's crust we use them as automobile fuels polythene bag and this is a material this also ethylene is involved is hydrocarbon to make this material and we use as a polythene bag and similarly hydrocarbons also find applications in drugs as well as in paints and
So on therefore they play a key role in daily life
So hydrocarbons ah can be classified broadly in the three types
So just we have seen fuels is a mixture of hydrocarbons and now let us they can be broadly divided into three types saturated hydrocarbons unsaturated hydrocarbons aromatic hydrocarbons examples saturated just we have seen ethane propane if you look at these molecules they have a carbon carbon single bond the hydrocarbons that contain carbon carbon single bonds it can be linear it can also be cyclic this molecule has three carbon atoms the linear molecule here also has three carbon atom right you have this has four carbon atoms it is closed one this called cyclopropane this is propane and
So these are examples for saturated hydrocarbons compounds that contain carbon-carbon single bonds unsaturated hydrocarbons carbon compounds that contain carbon carbon multiple bonds for examples this molecule has a carbon carbon double bond and
So you can write like this is carbon is bonded with two hydrogen atom again bonded with carbon it has a carbon carbon double bond
So this molecule has carbon carbon triple bond
So these compounds are called unsaturated hydrocarbons this also can be cyclic for example when you have the four carbon atoms it can be cyclic
So whenever you have the carbon-carbon multiple bonds double bond triple bonds those compound hydrocarbons are called unsaturated hydrocarbons the difference between these two hydrocarbons is it has two car hydrogens less this is c 2 h 6
So they have general formula for the linear one c n h 2 n plus 2 this is a common formula for the saturated hydrocarbons linear hydrocarbons cn two carbon and hydrogen is going to be six and if you compare these two this compound has 2 hydrogens less comparing to that they have the common formula cnh2n and this compound has 4 hydrogens less comparing to the alkane two hydrogens less comparing to the ethylene this more unsaturated hydrocarbon this example this this is called ethylene and this is called ethane they have the common formula c n h 2 n minus 2
So this is the name of this compound is ethane you see the difference ethane
So in this case the a n e is converted into ethene right a is changed to in ethene and in this case the a is converted e is con change to y ethylene these are the names of these compounds you can go on like this if you increase one more carbon is called this is propine propine propane this is propane this compound is propane a is changed to in propene if you have the corresponding this one triple bond then propion can go on anyway these are the examples for unsaturated hydrocarbons and if you look at all the compounds they have only carbon and hydrogen atoms aromatic hydrocarbons
So these class of compounds have a benzene ring as unit say for example if it can be benzene or a derivatives
So here what up you look at this compound is a cyclic compound you have the double bond single bond double bond single bond double bond that means it has six carbon atom and is bonded with the carbon is bonded with another carbon double bond and at the same time you have the c h one single hydrogen atom
So this compound is called aromatic compound and also this is derivatives right
So one of the hydrogen is replaced by methyl group called methyl benzene and this is benzene and this you have one more ring is this called naphthalene
So these also hydrocarbons look at it they have only carbon hydrogen atoms

So these kind of compounds is called aromatic hydrocarbons in this class now let us focus on alkanes just we have seen saturated hydrocarbons those are called alkanes and the first member of this series is methane we replace one of the hydrogen with methyl group then we get the next series ethane this is called methane this is ethane you can go on you replace the hydrogen you will get propane butane or the corresponding alkanes firstly let us look at the structure and bonding of alkanes
So this is a structure of methane you can look at this structure is the methane look at it carbon is bonded with the structure of methane it has tetrahedral geometry if you look at it it has a detonator geometry and
So the bond angle between this is one zero nine five degree the bond length is one point zero nine armstrong this bond length and this carbon involves sp3 hybrid orbital sp3 fibrous orbital that overlaps with s orbital of hydrogen you make bond the sigma bond the sigma bond the carbon has four c h sigma bonds these bonds are made by overlapping of sp3 hybridized orbital of the carbon with the s orbital of hydrogen you make four sigma bonds now let us go for ethane
So so this sp3 arbiter of this carbon overlaps with the sp3 carbon of this carbon you make a carbon garment sigma bond in addition to that this one of the sp3 hybrid of this carbon overlaps with the hydrogen s orbital make another sigma bond similarly overlapping of this sp3 orbital carbon sp3 hybridize orbital with this hydrogen make another sigma bond
So this is the structure of ethane if you look at it and you have the carbon carbon sigma bond this is formed due to the overlapping of the sp3 hybris after this carbon with the sp3 hybridized up this carbon to form the carbon-carbon sigma bond in addition to that there is a carbon hydrogen sigma bond there are three hydrogen carbon carbon hydrogen sigma bonds in this carbon and which is formed due to the overlapping of sp3 hydrogen of this carbon with this hydrogen s orbital similarly this one the bond length uh between these two carbon this bond length is 1.54 armstrong armstrong is 1.09 armstrong this one
So the carbon hydrogen bond length is 1.09 armstrong and this carbon-carbon bond length is 1.54 this is a structure and bonding of methane and ethane you can go on like this for other alkanes just we have seen the structure of methane is ethane they have tetrahedral geometry and
So they involve they have carbon carbon carbon hydrogen sigma bonds now let us see the norman clasher and isomerism
So methane ethane propane they have only one structure methane and ethane propane they no problem we can call methane ethane propane when you go for butane or higher alkanes butane
So there are two structures possible for this molecule
So one is the linear one the other alternative we can also have other structure
So both have same molecular formula c4 h10 c4
So they have same molecular formula but different structures they show different properties the boiling point is different
So to when you go for a pendant further there are three structures possible we look at this molecules they have c5 h12 c5 h12 c5 h2o these three compounds have same molecular formula c5 h12 however they have different properties different structures to name these compounds iupac international union pure and applied chemistry have introduced some rules to distinguish this common name these compounds that is called iupac norman clutcher
So using this iupac nomenclature you can name all the compounds but when you go for hexane you'll have more structures and heptane you will have with seven carbon atoms and octane eight carbon atoms known in nine carbon atoms taken ten carbon atoms will have number of structures using this norman culture and you can name all the compounds this is called iupac nomenclature and let us how you will name these compounds to name this compound you have to follow some guidelines and
So first what we have to do we have to find out the linear alkene there is no problem you can there are five carbon atoms you can call pentane when you go for branched one and
So what we have to do in this case we have to find out the longest chain in this molecule and you can there are two possibilities one two three this is one chain you have three carbon atoms the other other possibility is that three four
So you can name like this then one chain you have three carbon atoms if you name like this it comes four carbon atoms
So you have to find out the longest chain you have to start numbering the chain you have to otherwise you have to find out the longest chain in the molecule

So in this molecule this is the longest chain right not this one you have only three carbon atoms if you go in this way you have the four carbon atoms you have to find out the longest chain in the molecule once you find the longest chain now you have to look at it you have to start numbering the compound
So already i have done before the numbering but first you have to find out the longest chain then you start numbering the longest chain how will you there are two ways you can start numbering from here or there you can start numbering from here this is the right one if you start numbering here there is wrong one but what you have to do you have to start numbering where the substitution is present closer to the end
So if here if you look at it this one the substitution is present closer to this carbon this is the end and the substitution is present here therefore you have to start numbering from this carbon not from this side
So once then numbering is done now you have to uh combine you have to find out the substitution position and combine this one and with that one and in this case you have the methyl group
So just we have seen when you have four hydrogen atoms we call it as methane
So when you replace one of the hydrogen you write then we called methyl
So this is methane when you remove another hydrogen you have the c ch3 then we call it as methyl see the a n has been replaced similarly this is ethane the a n can be roughly for example and
So this is ethane right
So when you have this one substituent what happens in this case one of the hydrogen has been replaced
So this called ethyl all right ethan ethyl that a n has been replaced by yl similarly when you go for propane then when you have the ch3 ch2 ch2 substituent is called profile butyl pentyl
So on
So now what we have to have to bring the substitution as prefix and this in this case and position is two two methyl butane it has four carbon atoms
So the substitutions present and second carbon atom the present substitution is methyl group about two methyl butane the name of the compound is two methyl butane
So now let us look at this molecule and this is a you have to find out the longest chain anyway in this both ways same there is no problem then you have to start numbering the chain has three carbon atoms the substitution is present and second carbon atoms
So you have to write two comma two dimethyl propane
So if you have one carbon atom we call methane two carbon atoms ethane three propane four butane and pentane five carbon atoms six hexane seven heptane
So on and in this case you have the chain has three carbon atoms and the second carbon atom we have the two methyl group and
So so two comma two dimethyl propane the name of the compound is two comma two dimethyl propane here true methyl butane this is pentane
So in this way once if you understand this one you can name all the compounds
So now let us look at this one and in the case of butane and one is a linear structure another one is bronze structure ah this called butane there is no problem and name of this compound is the now you have to start numbering this compound here also no problem you have either way you can start numbering you have three carbon atoms and now you have to find out the sub presence of substitution position of the substitution at present and second carbon atom
So you have to write two methyl propane to methyl propane now let us name this compound
So this how will you name this compound first now we have to find out the longest chain in this molecule the longest chain is this one right
So longest chain has six carbon atoms this is the longest chain once you find after finding the longest chain then you have to find out where the substitution is now this is a two terminal is present in this this side on that side you have to find out which carbon which end is very close to the carbon that contains a substitution in this case here
So you have to start numbering from here
So numbering is done once numbering is done you have to find out the position of the substitution here the present and second carbon atoms and in this case present four carbon atoms
So now you have to write one comma four dimethyl that means sorry two gamma four dimethyl

the methyl group present and second carbon atoms and four carbon atom dimethyl hexane this iopac name of this compound
So next the primary secondary tertiary carbon atoms let us look at this molecule do or methane methane or the carbon contents bonded with only one carbon is called primary carbon atom
So this carbon is bonded with otherwise you can call terminal carbon it is bonded with one carbon atom is called primary carbon atom and in this case the carbon is bonded with two carbon atoms right one with the tertiary another one is the primary this is called secondary carbon atom when the carbon is bonded with this three carbon atoms four carbon atom this is called quaternary carbon atom this is called quaternary is bonded with four carbon atoms the other hand if it has this is called tertiary carbon atom
So this this means this carbon is bonded with three carbon atoms right and if it bonded with another carbon we call this quaternary carbon atom this is followed the nomenclature now let us look at the isomerism
So butane it can have two structures
So butane and two methyl propane and they have the same molecular formula c4 h10 for different structures right
So these they have different properties now this boiling point is different these two compounds
So the molecules have same molecular formula but different structures different properties they are called structural isomers
So this the relationship between these two compounds are structural isomers molecules have same molecular formula but different structure they call isomers the relationship between these two is structural isomers right for pentane we can have three structures they have different physical properties and these are called structural isomers they have same molecular formula c5 h12 right all have c5h12 but they have different structures the relationship between them is structural isomers
So far we have seen classic classification of hydrocarbons structure and bonding of methane and ethane they have detected geometry but the bond angle one zero one zero nine point five degree and they are non planar molecule then we have seen the iupac nomenclature and isomerism of alkanes ah now let us see the preparation of alkanes
So petroleum natural gas are the main source of hydrocarbons natural gas contains 80 percent methane 10 percent ethane 10 percent higher alkanes propane butane
So on this is a mixture of natural gas and petroleum contains hydrocarbons up to c forty is a mixture of hydrocarbons they are found in earth's crust together and
So we will see them in detail later now we will see the other methods that we use in the laboratory to prepare alkanes
So one of the common reaction we use in the laboratory to prepare alkanes from alkenes and alkynes do hydrogenation of unsaturated hydrocarbons the beginning we have seen carbon ethylene and acetylene as unsaturated hydrocarbons and when you react for example propane propane these unsaturated hydrocarbons with hydrogen here you need two molecule of hydrogen and when you treat this alkene with hydrogen the process of catalyst like palladium charcoal or platinum or nickel the alkene can react with hydrogen basically undergoes addition you get alkane similarly alkyne can be transformed to is a stereo specific reaction and what happens in these reactions you have your catalyst for example palladium charcoal the palladium charcoal when you treat exposed with a hydrogen hydrogen observed on the surface you form activate the hydrogen you form this kind of intermediate once if you have this intermediate the hydrogen is absorbed on the surface of the catalyst your alkene when you treat this with your alkene the alkene also can bind with your palladium by interaction by complex formation you have for example you have this kind of intermediate once you form this intermediate the hydrogen can transfer intra molecularly
So now you have the hydrogen is transferred you have already carbon you have this kind of intermediate
So you have another hydrogen here this can transfer again you have the reaction medium has a lot of hydrogen the hydrogen can observe here it can transfer to another carbon
So you will generate the reduced alkane and your catalyst is ah re generated
So now again it can react with hydrogen gas it can go on like this
So whenever you use less than 10 mole percent of this metal with respect to a substrate we call it as catalyst and it can go on like this with another hydrogen it catalyzed like this reaction

So this commonly used anyway this very simple alkene but when you have a larger alkene for example actin known in then very easy to reduce in the laboratory and we can get very pure reduced alkane
So in the case of alkyne what happens is similar way first what happens the alkane is reduced to alkene it depends upon the catalyst what you use the catalyst active the alkene can be further reduced to alkane
So it involves it requires two molecule of hydrogen and it requires one molecular hydrogen and in this reaction what happens alkene when we study the alkene and alkyne you see the structure the alkene is a planar molecule alkene is a non planar molecule right retrograde geometry the alkene is a planar molecule you have the top face or bottom face and your hydrogen is on the plane right and the alkene approaches the catalyst like this the bottom side the one hydrogen transfer then right the another catalyst and hydrogen is the another hydrogen comes basically both hydrogen are transferred the same phase of the alkene you get the alkane the reaction is the addition is syn addition the reaction is still specific and same thing happens in the case of alkane also right the alkene approaches like this the four both hydrogens are transferred the same phase of the alkyne then you get the alkene that alkene again further react and you get the also this reaction also syn addition reaction stays specific this is one of the common reaction we perform the laboratory to make alkanes from alkenes alkynes very easy reaction the second example is reduction using niacin hydrogen we have alkyl halide like bromo methane or bromo octane or any except it can be chlorine or it can be iodine no problem but if you have fluorine does not react when you react when you treat bromomethane with zinc hcl
So it can be reduced into methane and hbr
So this reduction reaction if you have alkyl halide like bromochloro iodo halides you can reduce them to the corresponding alkane you generate the hydrogen halide as a byproduct this another reaction used to prepare alkane the third example is woods coupling alkyl halide for example bromo methane can be cross coupled together if you have take two molecule of this react with two equivalent of sodium you can generate ethane symmetrical alkane with two molecule of sodium bromide this called woods coupling and this reaction what happens this bromo methane reacts with sodium to generate once you form this intermediate this can react with another molecule of bromomethane you get ethane and sodium bromide
So you generate two molecule of sodium bromide and ethane this is good to make a symmetrical alkanes but if you take a mixture of alkyl halide for example methyl bromide and ethyl bromide will not be good you will end up with mixture of compounds three compounds for example instead of methyl bromide you take a mixture of methyl and ethyl bromide when you react these two bromides with two equivalent of sodium you will end up with mixture of compounds you will have ethane this is this can be formed from the reaction of this methyl bromide in addition to that you also will have ah these two molecules can react then you generate butane and if they coupled together you will get propane the basically you will end up with mixture of three compounds ethane propane butane is it will be very difficult to separate these hydrocarbons therefore the woods coupling is very good to make symmetrical alkanes
So far we have seen two methods only hydrogenation of saturated unsaturated hydrocarbons like ethylene and alkyne to alkanes then we have seen the coupling of the reduction of alkyl halide to alkene using zinc hcl and where you generate niacin hydrogen that reduces alkyl halide to alkane then we have seen woods coupling and it will be good uh to make symmetrical alkenes the next reaction is decarboxylation reactions if you have for example sodium acetate sodium copper oxalate when you treat sodium copper oscillate with the soda lime when you heat and
So you generate alkane
So the byproduct is sodium carbonate in this and this one of the method used to make alkane this whenever you treat sodium carboxylate with soda lime and heat it you can generate alkane and the by-product is sodium carbonate this is called decomposition reaction you lose one carbon ah in this instead of two carbons you will get only ah one carbon less hydrocarbon alkanes the last example is gulf synthesis you can also if you have the sodium potassium copper slate for example sodium acetate when you do electrolysis it can be converted into symmetrical alkene ethane and you will generate sodium hydroxide when you do electrolysis in water
So you generate sodium hydroxide and carbon dioxide hydrogen and sodium hydroxide this will be the byproduct ah this also very common method to make alkanes how the reaction

takes place anode it can lose two molecule of we take sodium acetate you can lose two electrons and you generate the radical this radical can release carbon dioxide generate the methyl radical two methyl radical these two methyl radical combined together you generate the ethane this what happens at anode at cathode water you have two electrons then you generate o h minus plus h dot
So it can be now this o h minus can two o h minus already have the case the on already have two sodium plus they can react together this you take two molecule of this take two and then you generate and this two can combine together you generate h2
So cathode it takes ah this two electrons reduce it the water is converted into hydrogen gas and sodium hydroxide at another you generate the alkane carbon dioxide
So with this i conclude today's lecture and we will see alkenes all kinds the next lectures thank you very much you