Hydrostatics and Stability
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Module No. # 01
Lecture No. # 01
Introduction

Hello everybody. We are going to start our series of lectures on Hydrostatics and stability.

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This will be the first course that you are doing on Naval architecture in the department. So, this will be an introductory course, but, first we will be dealing with some of the basic principles, then into more advanced concepts in Hydrostatics and stability.

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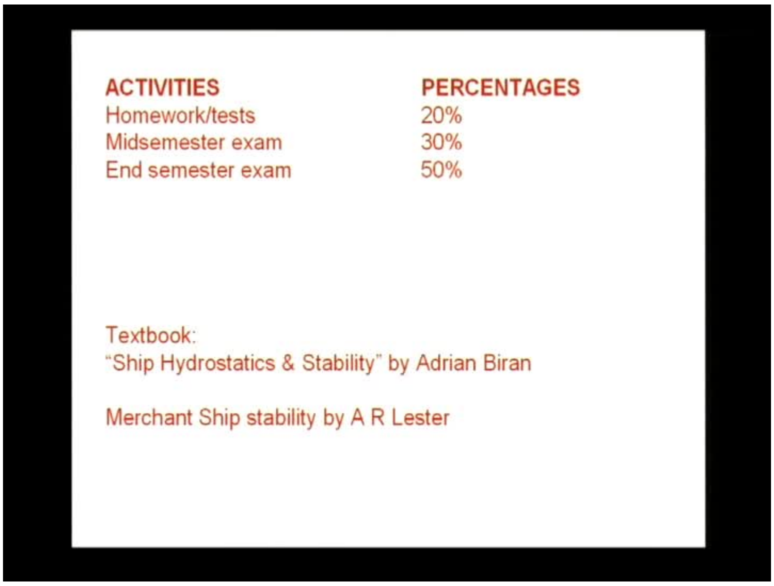

Now, the course will be divided into the following percentage will be used: homework, mid semester and end semester examination.

The textbooks that we are following will be Ship Hydrostatics and Stability by Adrian Biran. Now, this book is available in the library, as well as it is available in the market and this is the most standard book used for hydrostatics and stability. Adrian Biran is the name of the author.

And we are also using another book that is Merchant Ship stability; that is the second book; that is by A R Lester; both books will be used for this course. A R Lester, it is a book on problems mostly, and so you will be able to solve problem which will give an idea of what to do when face such face with such problems in naval architecture.

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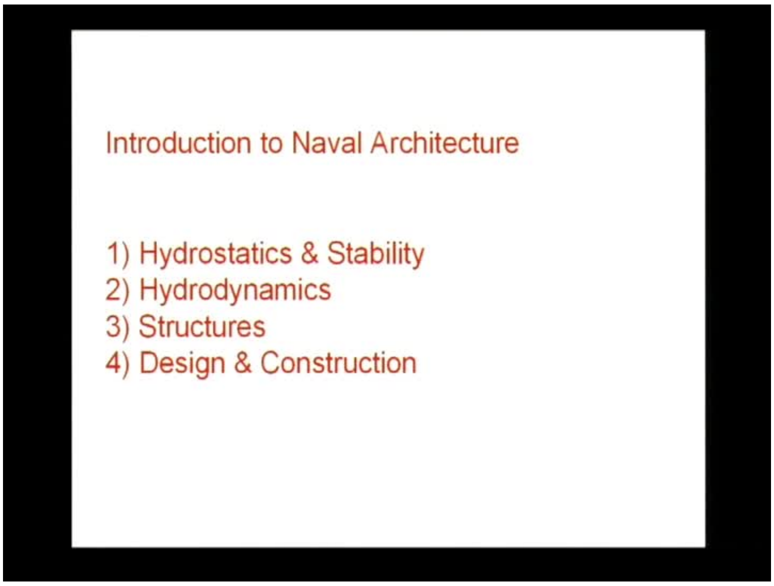

Now, if I had to… So, as I said before, this will be the first course that you will be doing in the department. So, this is the primary course that everybody does when they enter into naval architecture department.

Mainly there are four types of courses that you will be faced with in the course of B tech or M tech program. There will be courses on hydrostatics and stability; that is what I am going to teach this semester. Then, there will be courses on Hydrodynamics; that is second thing; that is hydrodynamics.

I will explain quickly what will be the different aspects of these different things that I have written here. Then, thirdly, we will be dealing with courses on structures where you will be doing structural computation on ships. So, hydrodynamics is about the fluids, and structures is about the solids.

Then, finally, we will have a lot of courses on design and construction where, you deal with the parameters of design like general arrangement, CAD, CAM; you will be dealing with softwares like Maxsurf etcetera; it is another aspect of naval architecture.

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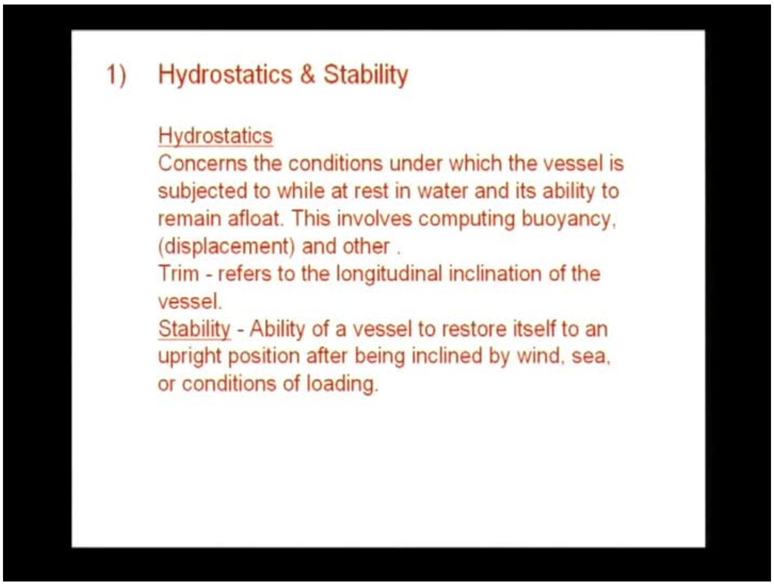

So, first of all, as I told you, you will be dealing with courses on hydrostatics and stability.

What does this subject really contain? What is it really about? Now, hydrostatics is basically about condition under which the vessel is subjected to... We will be studying the conditions at which the vessel is subjected to different loads and moments, and we will be dealing with its ability to remain a float; means, even though the ship is subjected to different kinds of loads and moments, we try to see how good it is at remaining a float as well as straight.

We will go into the straight parameters next. So, this involves study of things like buoyancy which is the ability of the water to push up the vessel and the weight of the vessel itself which brings its down; so, for one acting downward; one for acting upwards; the weight of gravity acting downwards and weight of buoyancy acting upwards. The balance of these two which is of course, Archimedes' principle that we will come to in next lecture.

So, you will have these parameters. Then, you will be that is one aspect of hydrostatics. Then, you will be dealing with trimming. Trimming literally means that if you have a vessel, if you have a vessel like this, what is the ability? That is what happens when ship goes like this; when it tits in this what we will call as longitudinal and transverse directions, that is what this is; this is known as longitudinal direction, that is the direction in which in direction along the length of the ship and this is called transverse (Refer Slide Time: 05:15 to 05:35).

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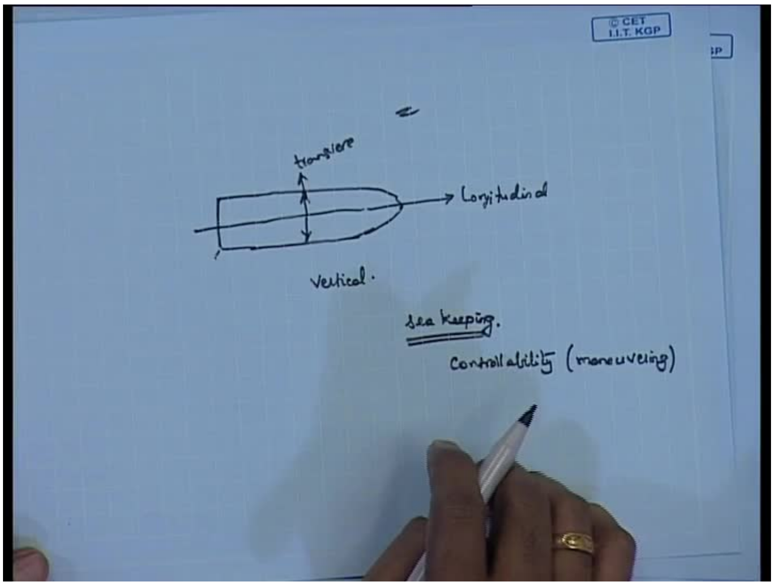

So, if you have a ship like this, then this direction, we usually call it as longitudinal and this direction we call it as transverse and the third one, of course, is known as the vertical. So, we have three directions for our ship. We have the longitudinal, transverse and vertical directions.

So, of these, if you have the longitudinal, if this is the longitudinal part, this is the transverse part and this is the vertical part. Suppose that the ship is turning like this, this is called trimming. There are lot of conditions associated with trimming and if the ship tills like this (Refer Slide time: 06:48), if this is the longitudinal direction and if it tilts like this, it is known as heeling and so these are parameters that we need. You will be dealing with what happens to a ship when it undergoes such moments either trimming or heeling or there are other kinds of moments like pitching, rolling, heaving like that; that and all we will do later.

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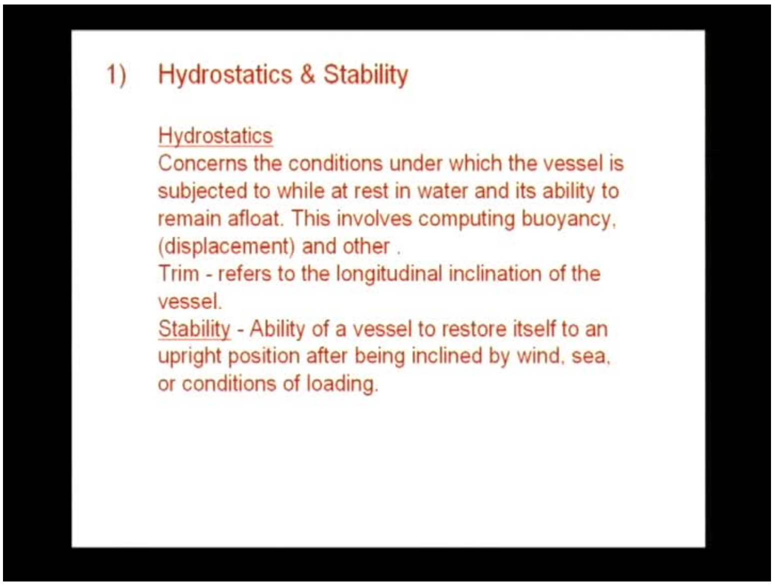

So, these conditions, we will be dealing with. These conditions are studied under the concepts of stability and hydrostatics. Then finally, the main thing that is how the vessel is able to restore itself to an upright position after being inclined by wind, sea or conditions of loading.

By loading, we mean what goes into the ship at the time of sailing; when it is sailing, what is the weight on the ship? That is what you mean by loading of the ship; loading in a ship or loading on the ship is given by these parameters.

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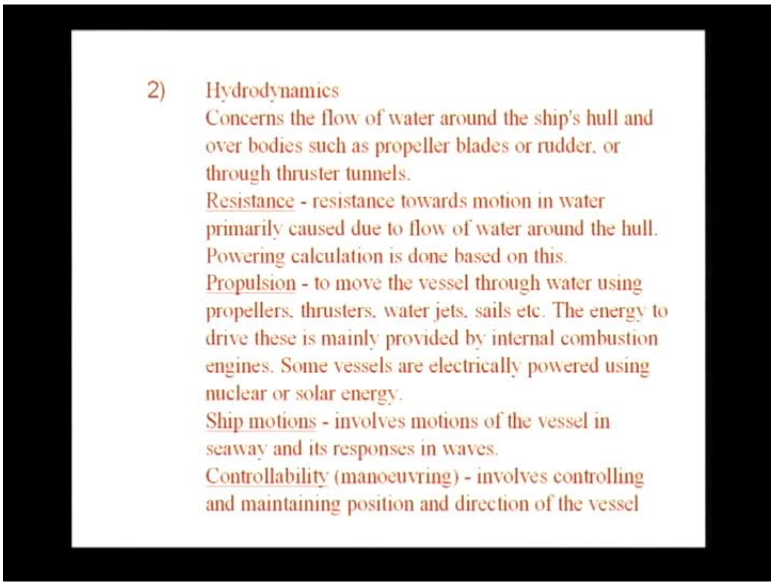

Then, that is first of all what we will be dealing with in hydrostatics. Then, the next one, the next important concept that we will be dealing with is not in this course, of course, that the next important thing that you will be dealing with in some other courses will be hydrodynamics. Hydrodynamics concerns the flow of water around the ship's hull and over bodies such as propeller blades or rudder or through thruster tunnels.

Anyway, first of all, it is it concerns the study of flows. Hydrodynamics is the study of flows. So, the main flow is… So, if a ship is like this, it usually has a propeller at the end, a rudder at the end, and lot of people do a lot of research on how the flow occurs across the propeller blades. Propeller is rotating here at the back of the ship, in the behind part of the ship, and water comes and goes. So, that is dealing with the propulsion. There will be different studies of the flow around such propellers.

Then, there will be studies of resistance; resistance means resistance towards motion of motion in water primarily caused due to flow of water around the hull; powering calculation is done based on this.

So, what it means that when have a ship and it literally ploughs through water, it will be facing, it will be encountering drag. So, this drag will cause the ship to slowdown and it takes power. That is what the engines develop. It takes the engine power to move again the drag offered by water. So, study of that, where you deal with different kinds of resistances wave resistance, king friction resistance etcetera is known as resistance calculations, resistance studies; that is done also in hydrodynamics.

Then, we go into propulsion. I have already mentioned propulsion; that is to move the vessel through water using propellers, water jets or thrusters. The energy to drive these is primarily provided by internal combustion engines. Some vessels are electrically powered. Now, this is the second aspect of hydrodynamics; we deal with propulsion.

As I just said, it is the action of propeller that moves the ship forward. The propeller itself is rotated by the help of engines and the engines are connected to the propeller through shafts. And because of this moment, there is the revolving of the propeller and because of the thrust developed due to revolving of the propeller, the ship moves forward. So, that is propulsion.

Then there is a lot of ship motions. I would put this under a category of problems known as sea keeping. So, this is a different clause of problem. This is known as sea keeping and another thing that comes along with it is controllability or we call it maneuvering; so, maneuvering; controllability and maneuvering. So, sea keeping and maneuvering is another course by itself; that is also part of this NPTEL. You can watch that. So, we have these different parts that are coming under the category of hydrodynamics.

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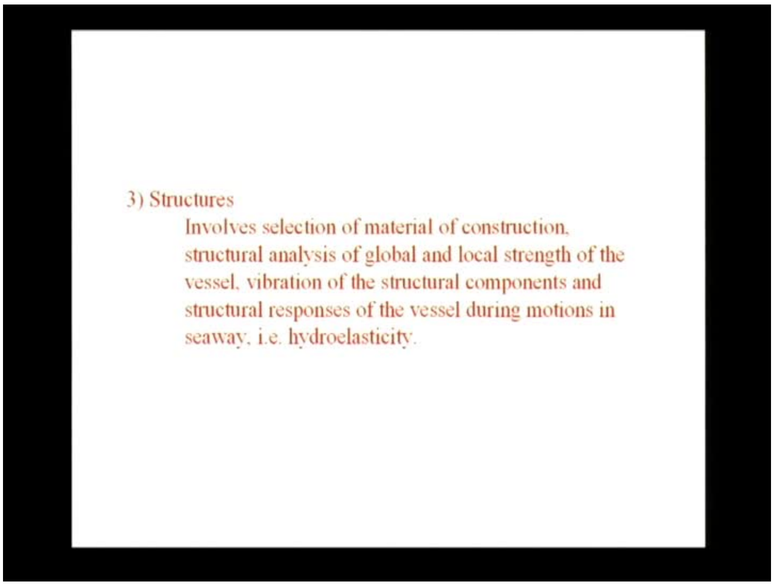

And then, structures - structures is a different category of problems whereby you will be dealing with the structural strength, the structural rigidity, the ship strength. Really, it would be dealing with the structural aspect of the of the ship. Studying different things like the strength of the girder, strength of the bulkhead, then how many bulkhead should be there? bulkhead These are all the terms in naval architecture which you will be coming across in the coming years. You will be dealing these courses which deal with structures and even the vibration of structural components comes under this category.

The vibration of floating structures is again another huge topic of study. Different types of ship or an offshore platform undergoes different types of loads; wave loads on it bridge cause wave loads, current loads etcetera on it which cause it to fatigue in it and it causes different structural problems. So, studying all those under the category of structures.

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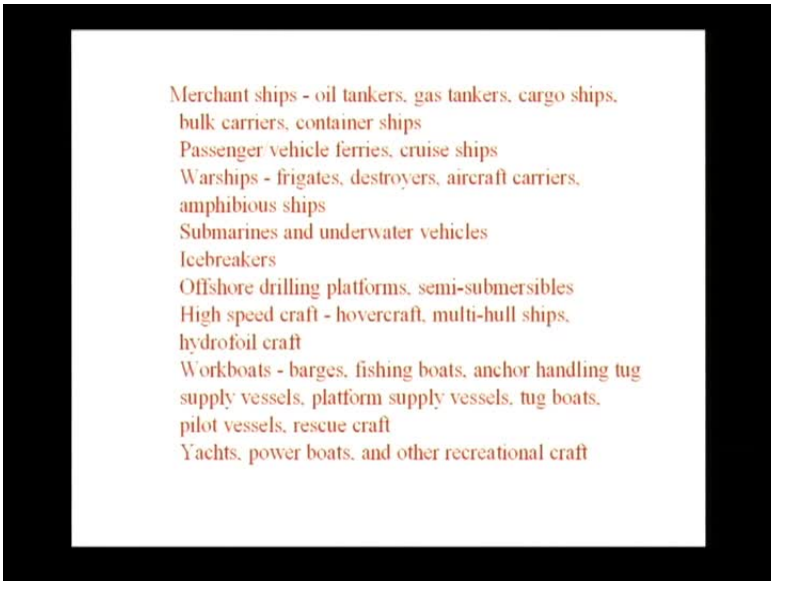

And then finally, and then we also have different kinds of ships: we have oil tankers, gas tankers, cargo ships, bulk carriers, container ships are different types of ships. Then, you have passenger ferries, cruise ships, warships. which come a In which come the category of warships comes frigates, destroyers, aircraft carriers, amphibious ships, etcetera. Then, you have, of course, you know submarines and underwater vehicles, icebreakers.

Then, in ocean engineering, you know that we deal with other aspects; not just the ships, we deal with the offshore platforms as well. On that comes an offshore drilling platform, semi submersibles. Then, there are different kinds of small crafts which are… and small crafts or unconventional crafts, as we call it. They are some of the high speed craft, hovercraft, multi-hull ships, hydrofoil craft, etcetera; then, small workboats like barges, fishing boats, anchor handling tugs, platform supply vessels, tug boats, pilot vessels, rescue craft etcetera and yachts and different kinds. These are some of the different types of vessels that you will be coming across. And finally, in this, there is also…

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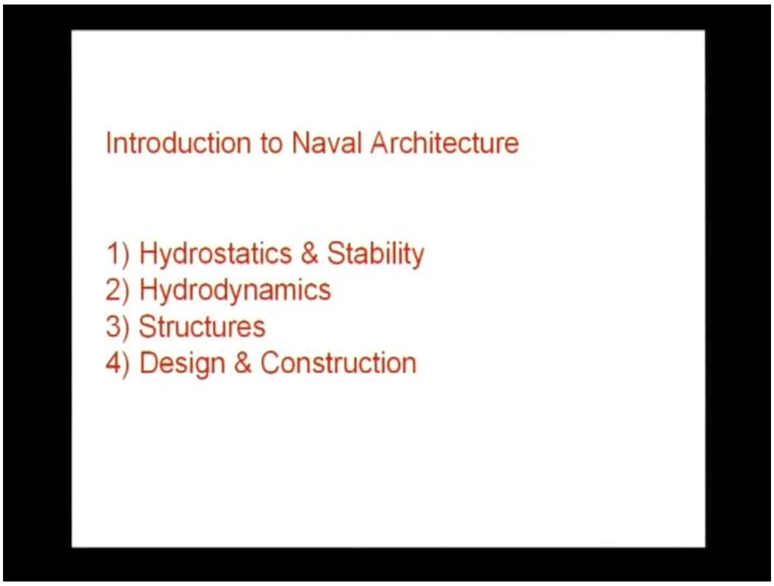

As I said before, there is also the design and construction; that is a fourth category of ship design problems. This basically involves CAD, CAM; computer aided design, computer aided manufacturing. Lot of things come under this category. The design of vessels is again a full course in itself. And in fact, it is two courses and CAD CAM in design; these are things that is very involving and that will be another course that you will be dealing with.

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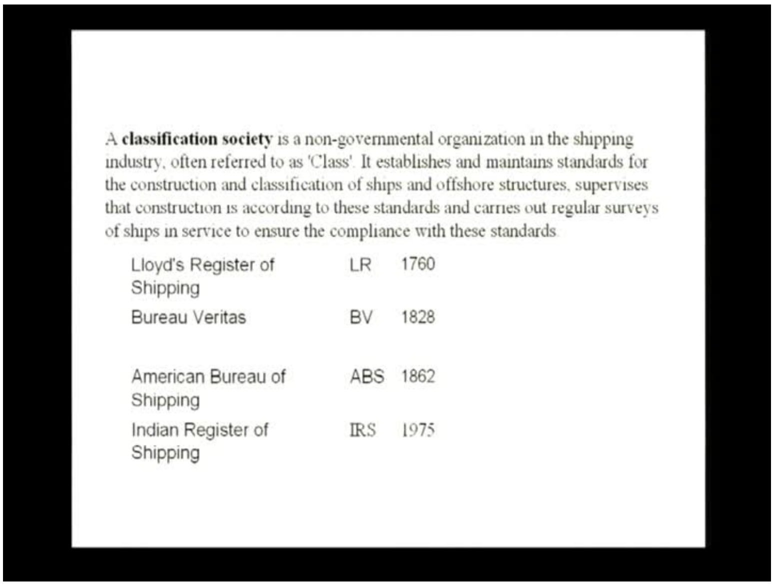

Then, here, I just give an introduction to you for different types of terms and the different information about naval architecture, where you will be dealing with all these things in the coming years.

Now, there is also something known as a classification society. It is a non-governmental organization in the shipping industry often referred to as class. Now, these classification societies establish and maintain the standards for the construction and classification of ships and offshore structures. Now, they also supervise the construction and make sure that the ships that are constructed follow this standard; they make sure that the ships are following these standards.

Now, there are different classification societies. The most important of the most commonly seen one is Lloyd's Register or American Bureau of Shipping. As the name itself suggests, Lloyd's Register is from UK and American Bureau of Shipping is from the US. Then, there is Bureau Veritas. And, in India also, we have such a classification society; this is known as Indian Register of Shipping – IRS. Given are the years in which these classification societies came into access, came into being used. and these

Now, this is just an introduction to some terms in naval architecture. Now, we will enter into the subject of hydrostatics and stability. First of all, we need to know some standard terms, standard common notations that we use in naval architecture. We will be using this throughout the length of the course; so, you will have to be familiar with it.

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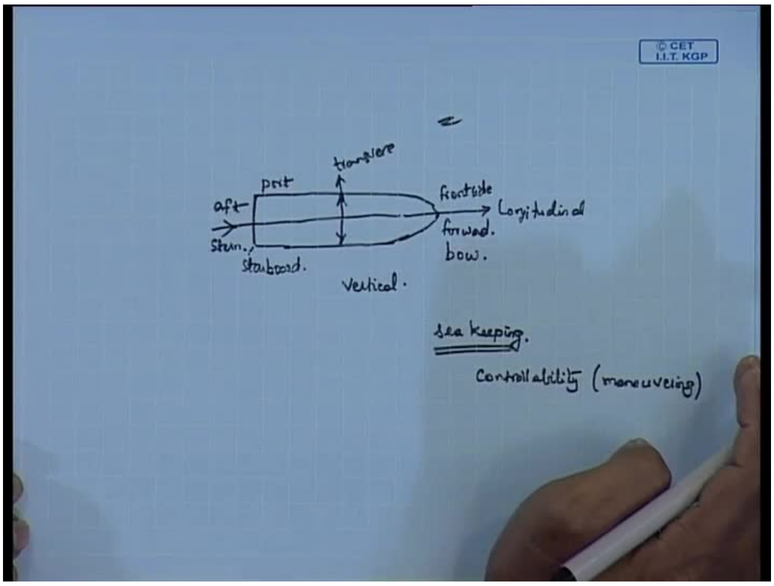

First of all, we come across if you look, we come across… let us assume that this is the ship; this is the forward part of the ship and this is the backward part of the ship (Refer Slide Time: 17:34). Now, suppose you are looking from here, looking viewing with the from the back backside, the right hand side of the ship is known as starboard and the left hand side of the ship is known as port.

So, this is the standard notation used for throughout the naval architecture. So, if you are looking from back, what you see on the right hand side is known as starboard and what you see on the left hand side is known as port; so, port and starboards sides. Also, there are some other terms like, this region, the backside of ship is known as aft of the ship; this is known as aft of the ship; this is also known as the stun of the ship; stun aft, the backward side - all stands for the same thing; its represents the backside of the ship.

Then, on the front side, this is known as front of front side of the ship. It is known as forward side. It is known as bow, the bow of the ship. So, these are some terms used. Aft and stun representing the backside of the ship and this representing the front side of the ship is called bow of the ship.

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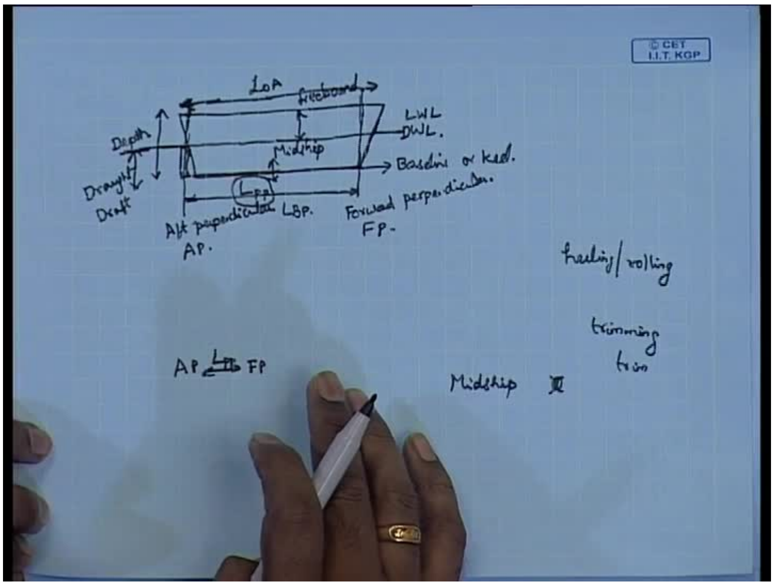

If you have a ship like this, suppose this is the rudder, rudder is the instrument in the ship which causes the ship to maneuver or turn; what causes the ship to turnaround is a rudder. Rudder is an aurof hydrofoil and this rudder we pass a line through this rudder. This line, this is the vertical line and this line is known as an aft perpendicular (Refer Slide Time: 20:10). This line at the aft of the ship which passes through the rudder or stock, the axis of the rudder is known as the aft perpendicular. Similarly, we have a small region at the front. Another vertical line passing through the front is known as the forward perpendicular. Now, this is always known as AP and this is always known as FP. So, AP and FP are the two lines that pass through the two ends of the ship.

Remember, there is a little part of the ship that is behind the aft perpendicular still; there is a little part of the ship that is forward of the forward perpendicular as well; it is not exactly at the front; it is slightly away from the front. So, you have the forward and aft perpendicular. Then, this line at the bottom is usually known as the base line or it is also known as keel. Then, now, if as you know, when a ship is floating in water, a part of the ship will be under the water, a part of the ship will be outside of the water. And so, there is a air water interface; there is a region of air water interface and this interface is known as the water line; we call it as water line. This line here is known as the water line – WL. We usually designate it as WL. It is the water line. It is also known as the design water line, design water line, water line etcetera. And then, there are some more parameters. This whole distance is known as the depth of the ship or what you really mean by the height of the ship is really is what we call it as the depth, It extends the distance from the keel of the ship to the top of the deck; to the top. The whole thing is known as the depth of the ship.

And you can have different depths in the forward and aft side because the forwards, it is not symmetrical between along the longitudinal direction. It is not symmetrical, but remember there we always consider the ship to be symmetrical in the transverse direction; means, the starboard side of the ship and the port side of the ship are just the mirror images of the each other. All calculations are done based on these assumptions and it is more or less designed like that and so calculations are slightly easier there.

So, this whole length is known as the depth of the ship and the part of the ship that is below the water line, this is known as water line I told you, so, below the design water line or the this is also known as load water line LWL (Refer Slide Time: 23:27). The region, the part of the ship that is below this water line, this distance is known as the draft of the ship.

It is either written as draft or draught; both of them represent the same thing; one is the British spelling and other is an American spelling; both representing the same thing. This is the draft of the ship. Then, as you can see, there can be different drafts in the forward and backward direction; backward part. So, you have the forward draft, aft draft and the region above this; this is known as the free board. This region we call it as free board.

Then, the distance between the aft perpendicular and the forward perpendicular, this whole distance which is pretty much the length of the ship is known as LPP - the length between the perpendiculars. It is also written as LBP for length between perpendiculars, but it is usually written as length from perpendicular to perpendicular - Lpp. This is the distance between the aft perpendicular and forward perpendicular. The distance between these two is known as Lpp - the length between perpendiculars.

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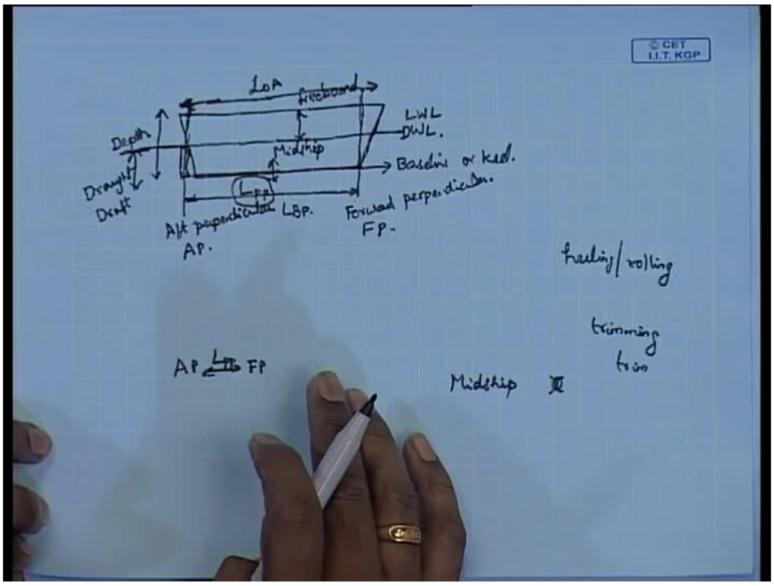

Then, the whole, as you see from the figure at the deck, you have a different length at the deck. This whole thing, this whole length is known as length OA; LOA - the length overall; so, the distance between the end the aft, most part of the part of the ship and the forward part of the ship. The distance in the deck in the deck region, the distance between the aft of the ship and the forward part of the ship; that distance we call it as LOA - length overall.

So, you have two lengths; whenever you write the details of the ship, remember you have two lengths - Lpp and LOA; length overall and length. Then, this region at the center is known as mid-ship. It is, as the name itself suggests, it is the mid part of the whole region; it is known as mid-ship.

A mid-ship is usually given by the symbol like this; it is usually written like this (Refer Slide Time: 26:01). So, if you see something written like this in a naval architecture chart or a naval architecture diagram on a, what we call it as a, lines plan, if you see this kind of thing written anywhere, it means a mid-ship. It is amidst the length of the ship.

Then, there are two types of motions of the ship which are also important here. One is… suppose this represents a ship; this is the longitudinal direction of ship and this is the transverse direction of the ship. So, suppose a ship moves like this, it is the movement of the ship in a transverse direction (Refer Slide time: 26:33). The rotational motion of a ship in a transverse direction is known as heeling or the dynamic part of it which means that it is continuously moving, the dynamic part of it known as rolling. Therefore, we have heeling, rolling - two aspects; heeling and rolling. Then, if the ship is in the longitudinal direction like this, if the ship moves like this, this type of motion is known as trimming (Refer Slide time: 27:21). That is known as trim. Trim means the motion that is trimming.

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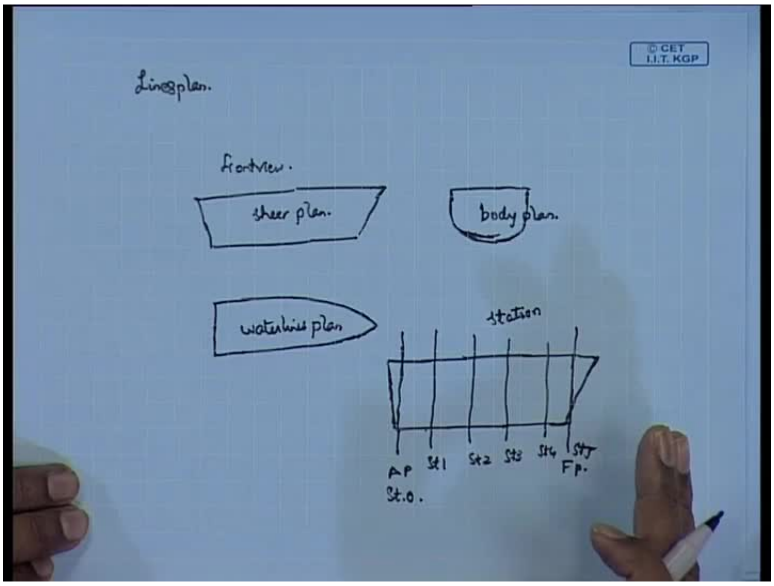

Then, we come into what we call it as… this is something that you will be doing… this is one course by itself; it is known as lines plan drawing. So, this, there is a word lines plan. So, we need to discuss little bit about lines plan before you go into doing such a thing - A lines plan.

I mean, you people, you have already done the engineering drawing course. So, in that, you would have done what we call it as the front view, top view and the side view. So, this is usually done in the engineering drawing. You see things from the different points of view and you draw it in a particular order. So, here also we have the same thing. We have a front view which looks something like this. So, this is the front view. Then, you will have a top view. Top view of the ship will look something like this (Refer Slide Time: 24:48 to 24:58).

So, this is the top view of the ship and you will have a side view of the ship. So, these are the three views of the ship. You see from… this is front view, means actually you are seeing from the side you might say; actually you are looking at from one side that is what we call it as front view, and then the top view looking from above and looking from one, looking really from the front is really is what is known as this view (Refer Slide Time: 29:39). Now, these views have their own characteristics names in naval architecture; for instance, this view is known as the sheer plan, this is known as water line plan and this is known as the body plan.

Now, before we do the lines plan itself, there are some terms that we need to be familiar with; first of all, suppose we have a ship like this (Refer Slide Time: 30:25); now, I told you we draw a line here which is known as aft perpendicular; there is we draw a line here which is known as forward perpendicular. Now, there is this distance between these two perpendiculars. Now, suppose that we divide the distance between the aft perpendicular and the forward perpendicular into let us say 10 region into 10 lines; we split it with n number of lines to divide the region between the aft perpendicular and forward perpendicular; when we do that, for instance, let us say, I am splitting with it 1 2 3 4 lines. I have divided these into 1 2 3 4 5 - 5 spaces and 5 lines; these lines that split the sheer plan into n spaces is known as, each of these is known as a station; the stations. So, these all are the stations. We call the aft perpendicular as usually station 0, station 1, station 2, station 3, station 4 and station 5, in this case.

Usually, we have about 10 stations all over the ship. From the rear of the ship to front of the ship, we have about, we will have about 10 stations. So, these are known as stations. So, as you can see, this length of the ship has been divided into different sections that these are known as the stations.

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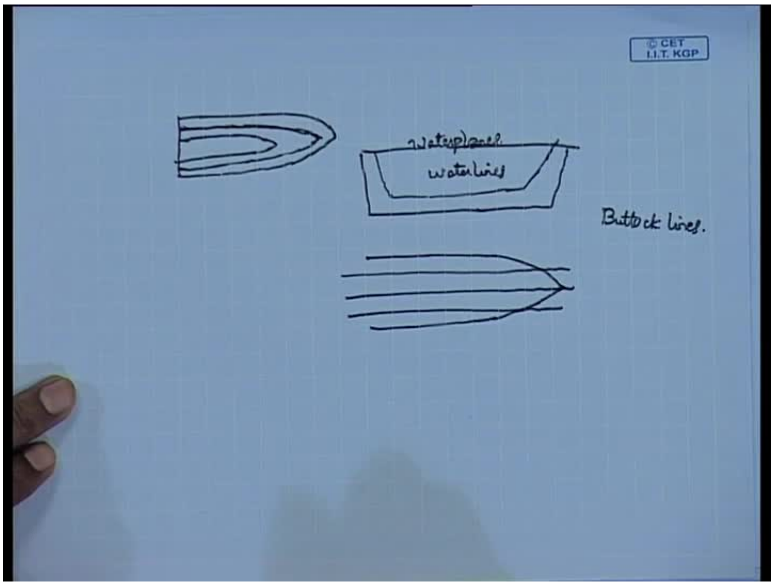

Same way, we can divide, suppose this is the if I had to consider this to be the depth of the ship; suppose I make sections like this; I cut it like this; slice this whole thing; I slice in this fashion and then you will get… So, you will be getting sections like this. You will have sections like this at different regions. Then, you will have like this. So, going from the back to the going from top to bottom or from bottom to top, you come across sections like this. These sections are called water planes. They, we call them as water plane. These sections are called as water planes and these lines are known as these lines that like this are known as water lines.

So, right now, you have two types of things: you have the water lines and the stations. So, these lines, when you look from the top, the side, the edge of the ship which when you draw a line through that from looking from top what you get are known as water lines.

Now, there is a third type of series of lines that is possible. That is known as, that is if you take the this to be the length of the ship, this is the longitudinal direction and this is the transverse direction of the ship and you slice it like this from here. If you slice it like this (Refer Slide time: 33:57). When you look from above, when you if this is the whole length of the ship, if you slice it in this direction, these lines will look in the front view like this. So, these lines will look like this in the front view. These lines are known as buttock lines; these lines are known as the buttock lines. So, we now have three types of lines: we have the stations, we have the water lines and the buttock lines. then So, once you have this, we will have to deal with, we will now deal with the lines plan. So, the lines plan will look like this.

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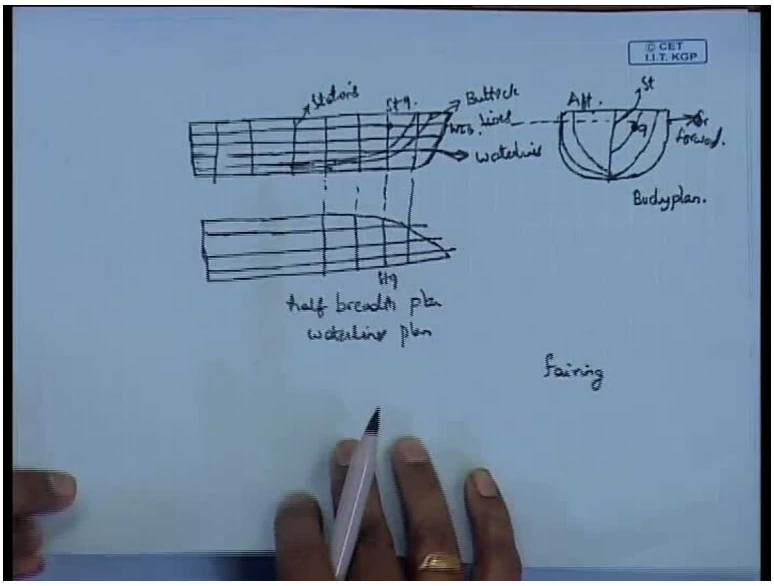

These are water lines. This is the sheer plan; looking from this, this view is sheer plan and these lines are known as water lines and here you have the stations and you will have some lines. It looks like this; lines looking like this, these lines are the buttock lines, these lines are the water lines and these lines are the stations.

So, this is how your sheer plan will look like at the end. At the end of your drawing, your sheer plan will look like this and your this water lines plan, as it is called, will look like this. I just told you before that the two sides of the ship that is the port and starboard sides, the port and star starboard sides are identical .We have only, I mean, the left side - the ports. Left side of the ship is very symmetrical to the right side of the ship. So, we really we need to draw only one half of the ship in the transverse direction; not whole length of the ship, but only one half of the ship we need to draw because the other half is exactly the same. So, we draw only the half of the breath of the ship; not the length; half the breath of the ship; that is known as the half breath plan. So, this is also known as the half breath plan.

Because only half the breath is drawn, half breath plan. It is also known as the, of course, it is also known as the water line plan and so here we will have some straight lines -

these are the buttock lines. And you will have some lines - the stations; like this, we will have all the stations. Now, we go into the third plan which will look like this. This is the view. As you will see, if you are looking from the bow of the ship, now this will look like different lines; will look like this (Refer Slide Time: 38:40). These are the different stations. As you can imagine a station, as I told you, the station is a sectional region like this; sectional cutting like this. So, if you look from here, the ship will look like this - a curve.

A curve - it will be maximum curved in the mid-ship; mid-ship will be the deepest; the depth will be maximum at the mid-ship. And, as you keep going above the ships, the ship, kind of, curves up. The curve of the ship will be going up. Therefore, the plan will become like this; finally, it will look like this (Refer Slide Time: 39:23 to 39:31). And again, just as I said before, we draw only one half of the ship. This half of the ship will be identical to this half of the ship. So, we adopted small strategy. We said that this side of the ship will do the front of the ship, the forward of the ship on the right side and the aft part of the ship is drawn on the left side. So, this will look something like this.

So, the aft of the ship will look something it will look like this and the forward part of the ship will look something like this. So, this is the aft and forward part of the ship and this is known as body plan (Refer Slide Time: 40:11)

Now, it is very very important that all these plans match in, you know, different points. In all these plans, the three plans, they match in terms of points. Each point in the sheer plan should match with a point in the water lines plan and it should match with a point in a body plan. For instance, a point here, let us say this is station 9; it stays in station 9; here, this should come in station 9 here also. And if it is on water line, let us say, this is water line 5 or water line 6. If it is on water line 6, then it should come on the same water line here. So, it is on station 9. Let us say this is station 9. So, it will be on station 9 and so it will be on such a water line; so, water line same line (Refer Slide Time: 40:40 to 41:07)

These all are of course, engineering drawing wonders. So, but it is very important that all the three views match; that is the body plan, the half grid plan and the sheer plan. So, all three points that I mention in each of these should match; otherwise, the drawing is not right.

And in addition, we say that the lines plan should be fair. Fairing is a process in which the lines are smooth. It is not just important that the point match; it is also important there all the lines that you are smooth. You know, if there are abrupt discontinuities and abrupt curves and abrupt curvatures in different parts of the ship, it cannot be it is not practical to construct the ship. So, it is important to fair these plans.

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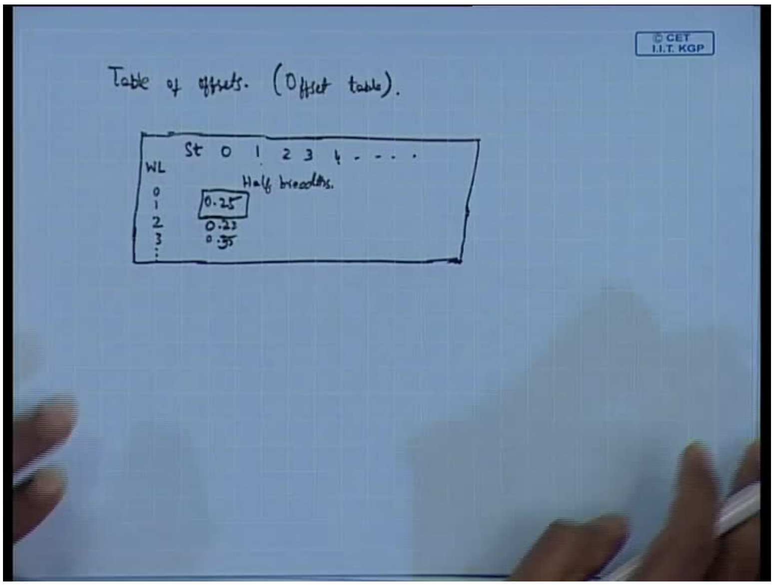

And, in addition, we have so while this information So, once you have the lines plan, you have the complete information about the ship. It is enough to draw the ship, but there is also a way in which this plan, these details of the ship is written in a concise form which also gives you the information about the ship. This we call it as the table of offsets or it is known as offset table. So, table of offset or offset table is the table that looks likes this; it looks like this (Refer Slide Time: 43:18).

So, in this table, it will look like this. There will be a series of stations; the horizontal, this you see, if you call this as the i and j, the i is equal to all these; it represents a half breath I mean it represents the station; 0 station, first station, second third, fourth stations like that.

And the vertical lines represent the water line 0, 1, 2, 3 and so when you say that this is let us say point 0.25, it means that the station 0 station 0 and water line 0; at the station 0 and water line 0, the half breath is 0.25. So, as I said, similarly, you have at So, these what you have written here is the half breath. It is for a particular station and for a particular water line. So, that is known as, this whole thing is known as offset table. So, you will have a complete table like this 0.25, 0.23, 0.15. You will have different half breaths at different stations. This will be increased by 0.35. So, these are known as table of offsets or the offset table. then in naval architecture we come across

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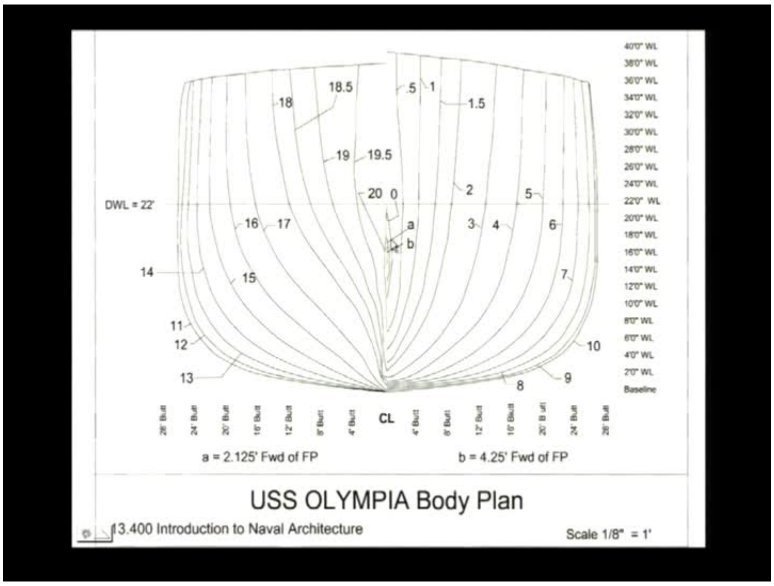

Actually, I have here, some of these drawings. These drawings, this represents same body plan of a ship known as USS Olympia; this is the body plan.

As you can see, this represents station 0.5. Now, that is another possibility. Suppose you divide the stations from 1 to 20, here as you can see, there are twenty stations. Now, you need not have just 1 2 3 4 integer number of stations; it is also possible to have some intermediate stations like for example, 0.5 station.

So, this station is 0.5 station one and then this is the 1.5, 2, 3, 4, 5. These stations, as you can see, are going towards the mid-ship. This is the mid-ship. So, this station 10 is the mid-ship station; 11 is also mid-ship.

So, you have these two things; more or less symmetrical station 10 and 11. Then, you go to the forward side; I mean this is the aft side; this is the forward side and this is the aft side. Right hand side represents the forward side; the left hand side represents the aft side. So, it goes up to station 19.5 to 20. The station at the forward most part is 20 and this is the body plan.

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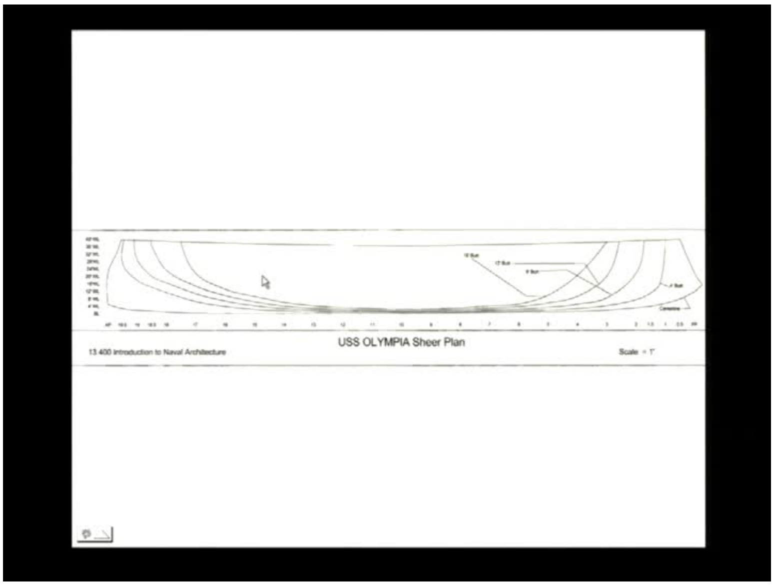

Now, this represents for the same ship, a sheer plan. Sheer plan, as I told you before, is the view from one side. So, this is how the ship looks like. This is It is These lines are the buttock lines. The stations are given here. This is the aft perpendicular, as you can see, and this is the forward perpendicular. So, you will have these lines; these are the buttock lines.

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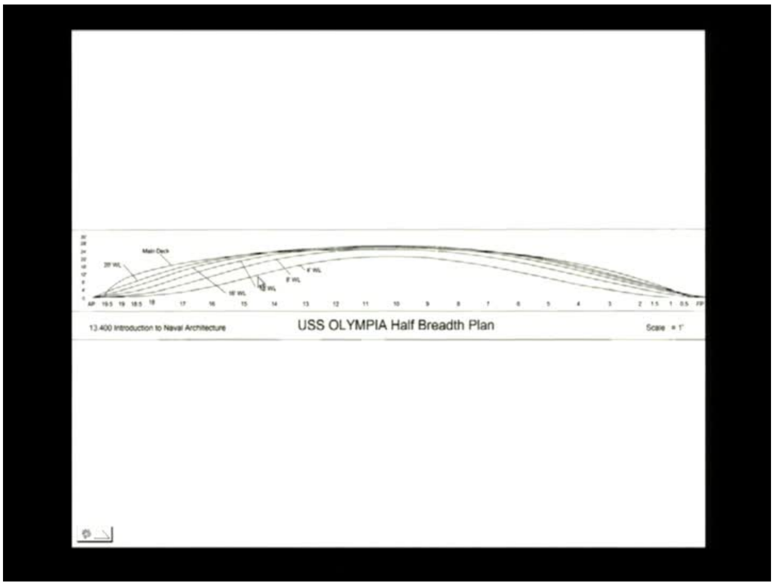

So, this is the sheer plan and then you will have the body half breath plan. These represent the half side of the ship. This represents for most probably the port side of the ship. This is the port and these are different water lines; water line 4, water line 8, like that different water lines look like this.

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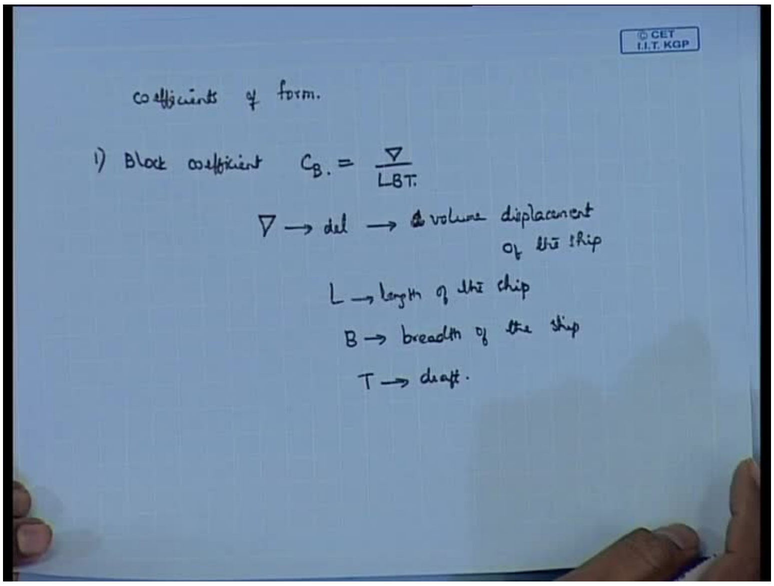

So, these are the different views of the ship in the lines plan. Now, we go into something that we call as the coefficients of form. Now, these are the different coefficients that we use. These coefficients are form or ratios of various parameters on the ship. The first one and the most important one is known as the block coefficient is known as a block coefficient Block coefficient is defined as C B. It is the very important parameter and this is equal to del divided LBT. Here, del represents… this I did not mention I should I mention del is known as the volume displacement of the ship.

This is the volume displacement of the ship; means that is the volume under water. That is what is known as del. The volume under water is known as the volume of displacement and that is known as del here, and into LBT. So, what you are doing is really, you have a ship and LBT is this under water volume which is like a rectangle L into B into T, so that you see another volume here; L is the length of the ship, B is the breath of the ship and T is the draft of the ship, not the depth of the ship; it is the draft of the ship.

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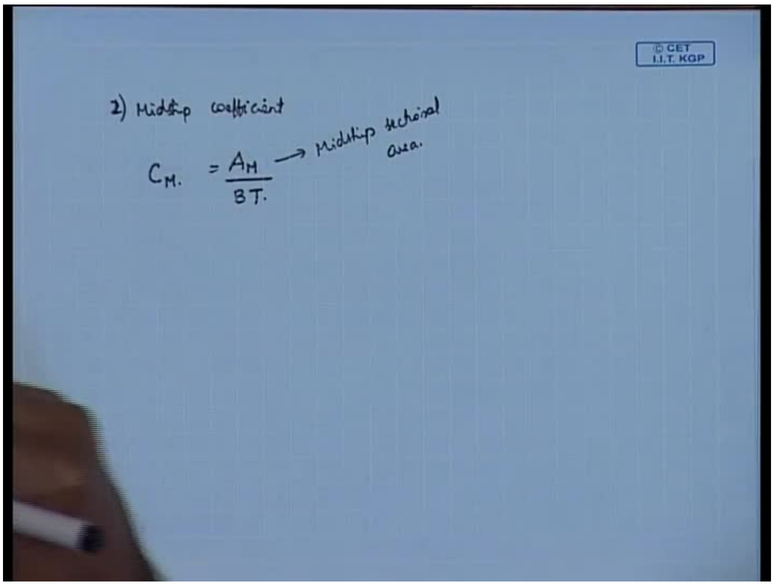

So, this is known as the block coefficient C B given by del divided by LBT. Then, there is a first coefficient of form. These, as I told you, these things are coefficient of form. First is block coefficient; then, next one is something known as mid-ship coefficient; this is known as mid-ship coefficient. Mid-ship coefficient is defined as A M. It is usually written as C M. It is known as A M divided by B into T.

Now, A M is the sectional area - mid-ship sectional area. A M is known as a mid-ship sectional area; so, A M divided by B into T - the mid-ship sectional area. If you have the ship like this, then this area that is known as the mid-ship sectional area; area underwater, of course, area underwater which is on that slice, that area in the mid-ship section is known as mid-ship sectional area. So, mid-ship sectional area divided by B into T; B is the breath, T is the draft. So, by that B into T, this is known as the mid-ship sectional area.

We have a couple of more coefficient of form that we will continue in the next lecture. So, for this lecture, I will stop here.

Thank you.