Security Analysis & Portfolio Management
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Lecture 16
Holding Period Yield etc.

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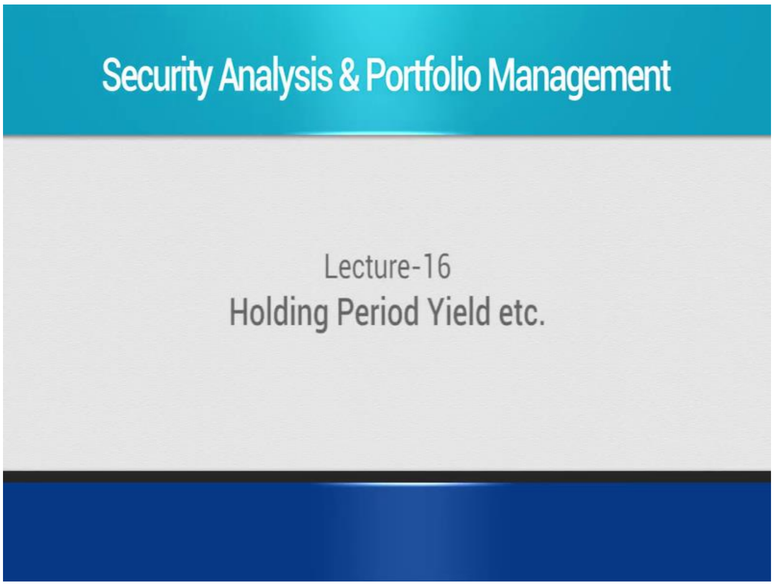

Welcome back. So, we are discussing about the carrying value of a bond, let us read it out.

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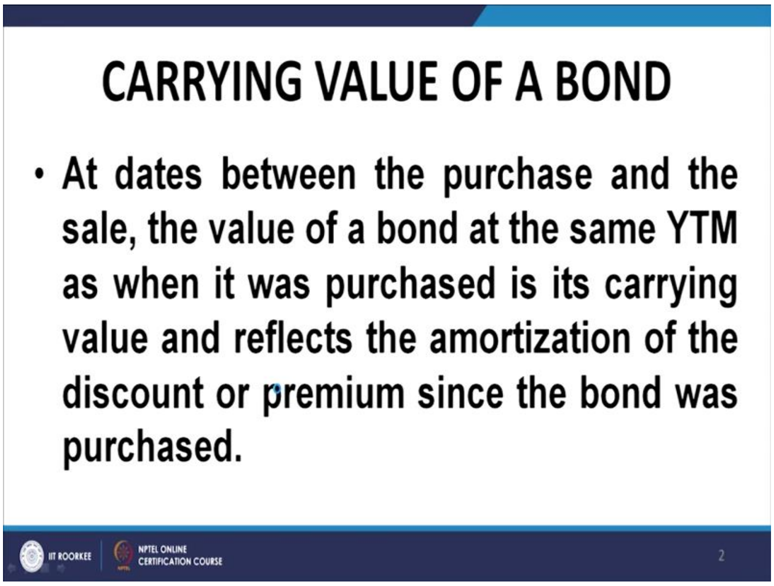

At dates between the purchase and the sale, the value of a bond at the same YTM as when it was purchased is its carrying value.

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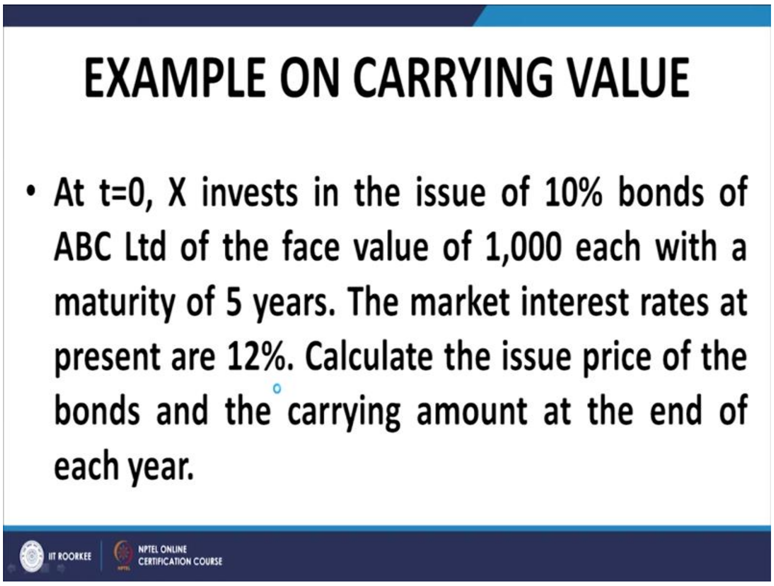

Then we took up this example: At t=0, X invests in the issue of 10% p.a. annual coupon bonds. The coupon rate is 10% p.a. Coupon frequency is annual. The term to maturity of the bonds is 5 years. We assume that the bonds are redeemable at par value of 1,000. The market interest rates at the ttiem of issue (t=0) are 12% p.a. We need to work out the issue price and the carrying value at the end of each year.

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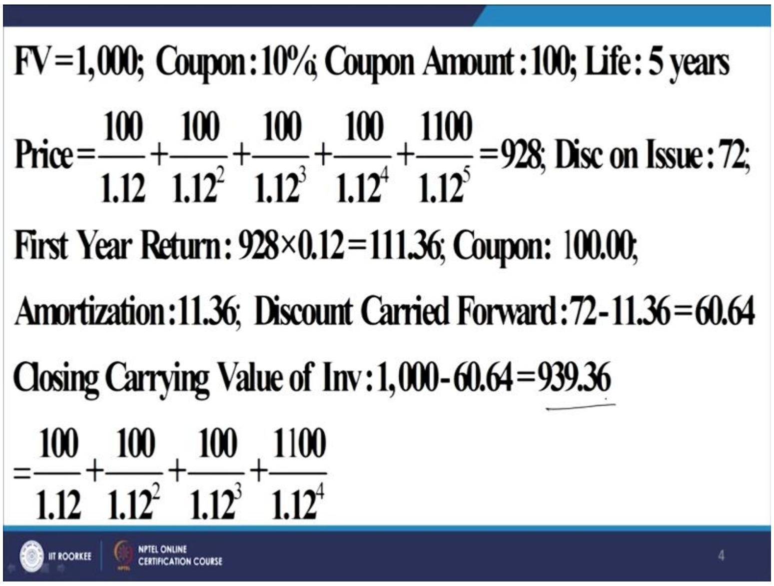

We then worked out the issue price by discounting the coupon payments and the redemption value at the prevailing market interest rate of 12% p.a. and arrived at 928. So, the bond would be sold at a discount of 72 per 1,000 of face value and it would be taken up by the investors not at 1,000, but at 928.

Let us investigate the inputs at the end of the first year. The first year return will be calculated for the investor on 928 which is his actual cash investment outflow. Further, the investor wants a return of 12% p.a. on his investment. So, the return to the investor for the first year will be 12% of 928=111.36.

Out of this, he will receive 100 as the 10% coupon payments on face value of 1,000. The remaining 11.36 represents income by way of the amortization of discount and the consequential appreciation of the carrying value from 928 to 928+11.36=939.36 at the end of the first year. In other words, the carrying value of the bond appreciates by 11.36 and this appreciation also constitutes a return to the investor. His total return now is 100 (coupon) +11.36 (amortization) = 111.36, which works out to 12% on his investment of 928.

I repeat, the return to the investor at the end of the first year will comprise of two parts: (i) the coupon payment of 100 and (ii) the amortization of discount of 11.36 i.e. the appreciation in carrying value of the investment from 928 by 11.36 to 939.36.

So, this new value is called the carrying value of the investment. We can also work out the carrying value by calculating the present value of the remaining future cash flows on the bond at the YTM rate. After he receives the coupon at the end of the first year, the remaining cash flows would be the coupon payments at the end of the second year (100), third year (100), fourth year (100) and fifth year (100) and the redemption of principal (1,000) at the endd of the fifth year. If we discount these cash flows at 12% p.a. (YTM), we again arrive at the same value, which is 939.36.

So, this 939.36 constitutes the carrying value of the bond at the end of the first year. I repeat, at the end of the first year. Obviously the carrying value will increase, as more and more discount gets amortized until it converges to the par value or the redemption value on the date of maturity of the bond.

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YEAR	CARRYING VALUE		EFFECTIVE	INTEREST	COUPON	AMORT
	OP	CL	RATE	INCOME	RECEIPT	IZATION
1.00	928.00	939.36	0.12	111.36	100.00	11.36
2.00	939.36	952.08	0.12	112.72	100.00	12.72
3.00	952.08	966.33	0.12	114.25	100.00	14.25
4.00	966.33	982.29	0.12	115.96	100.00	15.96
5.00	982.29	1000.17	0.12	117.88	100.00	17.88

The carrying value at the end of each of the five years is tabulated in this chart. At the end of the first year, the carrying value is 939.36. At the end of the second year, it is 952.08 and so on. The amount of amortization is given the last column. In the first year, as we worked out, it was 11.36, for the second year it is 12.72, third year 14.25, 15.96 in the fourth year and 17.88 in the fifth year. So, at the end of the fifth year, if we look at the carrying value, it becomes equal to the redemption value, which is as it should be.

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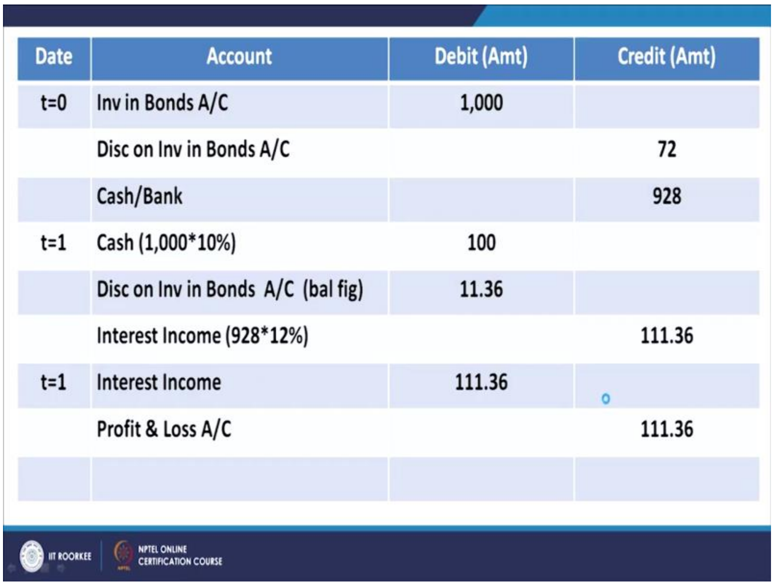
- Principal = $1,000; Coupon interest rate = 10%, paid annually; Maturity = 5 years.
- Return the market demands on the bond on the day we are valuing it = 12%. Issued at 92.8 (i.e., 92.8% of face value).
- At investment, cash decreases by $928 and Bonds Investment A/C increases by $1,000. The difference is shown as Discount on Bonds Investment.

ASSETS =		LIABILITIES +		OWNERS' EQUITY	
+$1000	Bonds Investment A/C				
-$72	Disc				
+$928	Net Investment				
-$928	Cash				



Date	Account	Debit (Amt)	Credit (Amt)
t=0	Inv in Bonds A/C	1,000	
	Disc on Inv in Bonds A/C		72
	Cash/Bank		928
t=1	Cash (1,000*10%)	100	
	Disc on Inv in Bonds A/C (bal fig)	11.36	
	Interest Income (928*12%)		111.36
t=1	Interest Income	111.36	
	Profit & Loss A/C		111.36

These two slides demonstrate the accounting procedure in respect of this particular bond. I leave it as an exercise for the learners to study it at their convenience.

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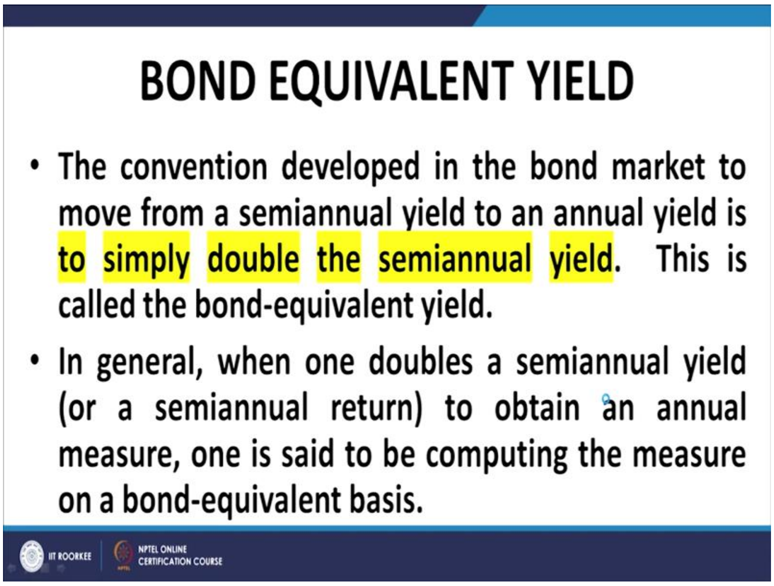

Now, I discuss the bond equivalent yield. As I mentioned much earlier on, that in India, as well as in the US, the payments of coupons are usually semi-annual, at least in the case of government treasuries. Coupons are paid at intervals of six months.

So, how do we work out the annualized yield or annual rate of return? How do we quote the annualized return on these instruments? This is called the bond equivalent yield. Now, to work out the bond equivalent yield, we work out the YTM of the instrument assuming that each time period is of six months. That is, we double the number of years and half the coupon rate. Using the current market price, we work out the 6-monthly YTM. We, then double this 6-monthly YTM to get the bond equivalent yield. Let me illustrate by an example.

Let us say we have a 10% p.a. government bond which has a face value of 1,000 and term to maturity of 5 years. We want to work out the bond equivalent yield of this instrument. Let us assume that the current market price of the bond is 960.

What we do is, we equate the current market price (960) to the discounted value of each coupon (50). However, and the number of discounting periods would not be 5, it would be 10 half years. Of course, at the end of the 10 half years, there will the redemption proceeds which will also need to be discounting for 10 half-years. So, the required equation that we have to solve is: $\mathbf{960 = 50\sum_{t=1}^{10}\frac{1}{(1+y)^t}+\frac{1000}{(1+y)^{10}};\ y_b = 2y}$. Whatever value of y we get in this equation, we simply double this value and we get the bond equivalent yield y_b. So, that is how the bond equivalent yield is quoted on an annualized basis.

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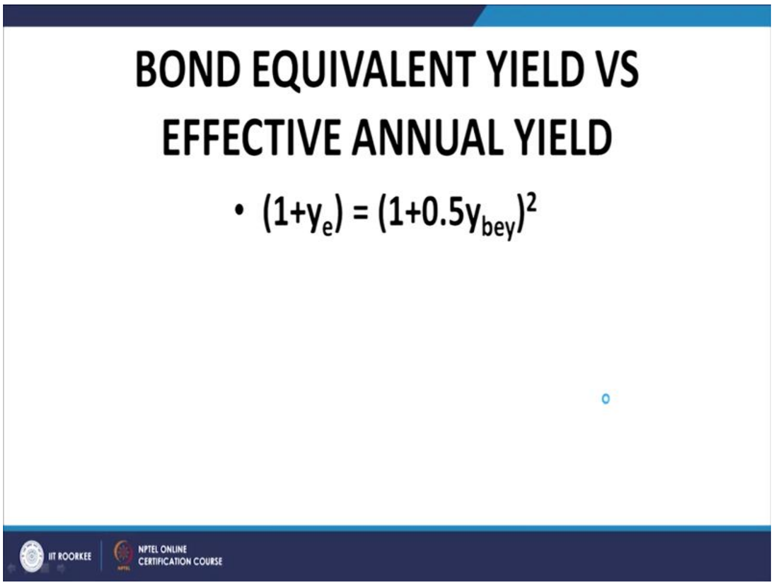

What is the relation between the bond equivalent yield and the effective annual yield? Well, that is given on this slide. We have: $\mathbf{i_e = y = \left(1+\frac{y_b}{2}\right)^2 - 1}$

So, this is how the bond equivalent yield is calculated. Let me repeat once again, we half the coupon rate and then multiply by the face value to get the coupon payment at the end of each half year, we discount all these coupon payments and the redemption proceeds assuming the half year periods as units of time instead of the full year period as unit of time. In other words, we double the number of years for which the bond exists. On the basis of the discount rate which equates the current market price to the discounted value of the coupons and the redemption value, we arrive at the half yearly YTM. We, then, double this half yearly YTM and we get the bond equivalent yield.

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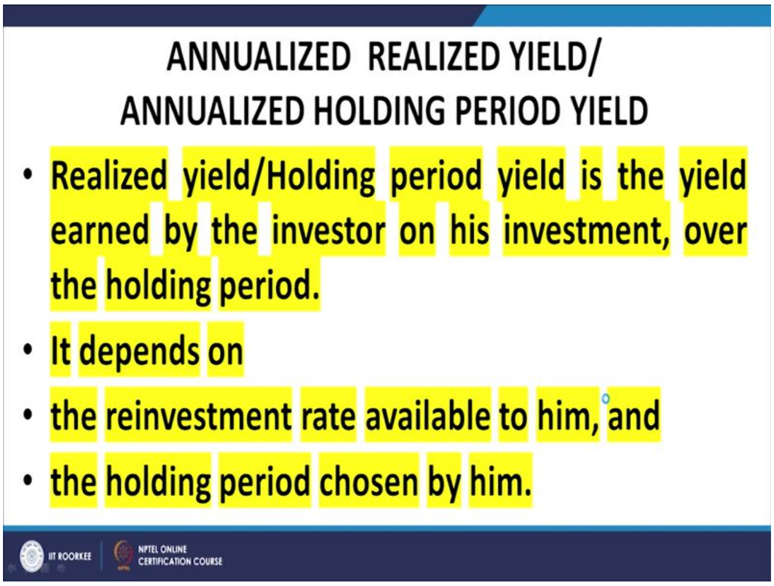

Now we come to the most important measure called the annualized holding period yield, which is called the effective annual yield. But before we get to that, let me talk about the holding period yield.

The holding period yield is the yield that is actually earned or projected to be earned by the investor on his investment based on his perception. So, this yield measure relaxes the assumptions of the YTM viz. the reinvestment rate is equal to the YTM by default and the investor holds the bond up to maturity.

We relax both of these assumptions. We now use an explicit estimate/ actual value for the reinvestment rate and we also consider the projected/actual holding period which may not equal the maturity of the instrument. It may be less than the maturity of the instrument depending on how long is the investment horizon of the investor.

So, obviously, the holding period yield would depend on the reinvestment rate & holding period that are inputted by the investor. So, both the assumptions that went into the YTM are now relaxed. Let us see what is the cost that we pay for rselaxing these assumptions.

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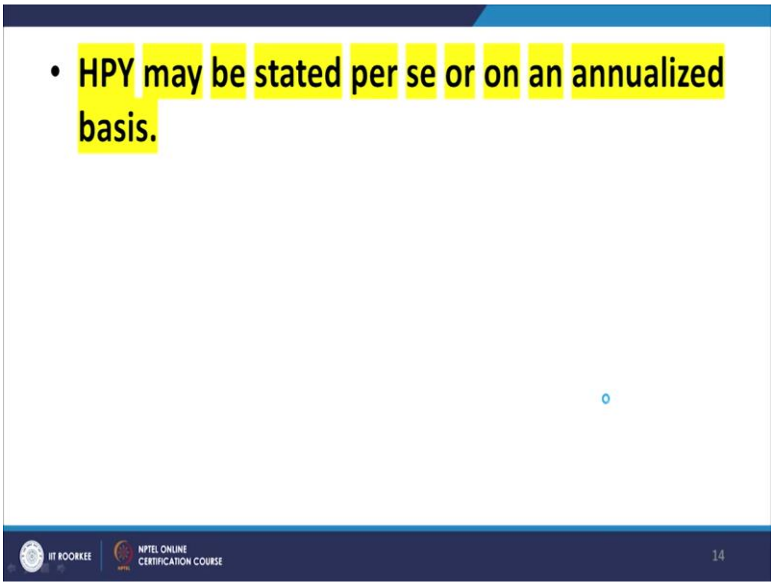

The holding period yield maybe stated as per se, that is, for the actual holding period e.g. if we are holding the bond for 2 years, we compute the return for 2 years and on that basis we obtain the 2 year holding period yield. Alternatively, more often, we annualize the yield and then express it on a per annum basis. Then, we get the annualized holding period yield, which is equal to the effective annual yield as well.

Now, as I mentioned just now, the holding period yield inputs a holding period as per the requirement of the investor. It also inputs a reinvestment rate spectrum, which is again estimated by the analyst or the investor.

Now, because the bond is not going to be held up to maturity, the liquidation proceeds are not precisely known upfront. The value at which the bond will sell in the market can only be estimated, it is not a part of the contract of issue. Let me repeat, if the bond was to be held to maturity, the redemption value of the investment or the exit value of the investment would be equal to the value that is given in the contract of issue. But if we exit the investment before the maturity of the bond, then we have to exit the investment by selling it in the market. It is at this point that randomness creeps in when we have to estimate the market price at which the investment will be liquidated.

Of course, if it is actual holding period yield then we know the actual price at which we exited the investment. So, there is no ambiguity. But if we are trying to project a holding period yield on the basis of our estimates, we also need to estimate the market price at which we will exit the investment.

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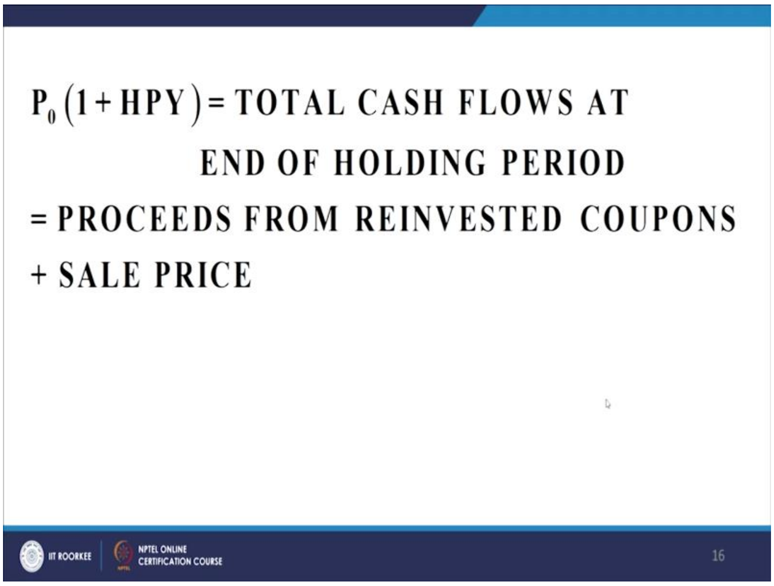

Now, this is the formula for the holding period yield: $P_0(1+HPY)=TCF\ (H)$ i.e.Total Cash Flows at the end of the holding period= Proceeds from reinvested coupons+Sale Price of bond at end of holding period. P_0 is the entry price at which we entered the investment.

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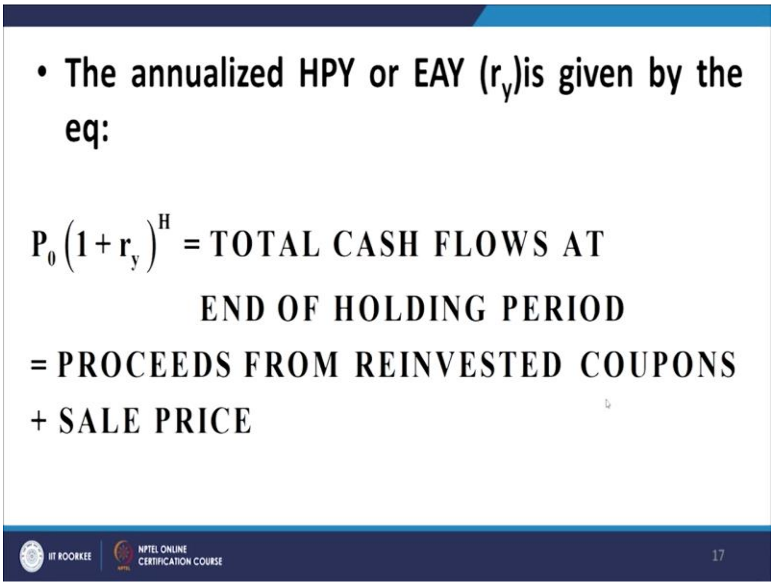

And if we want to annualize the holding period yield r_y, we use the formula: $P_0(1+r_y)^H=TCF(H)$ i.e.Total Cash Flows at the end of the holding period= Proceeds from reinvested coupons + Sale Price of bond at end of holding period. P_0 is the entry price at which we entered the investment.

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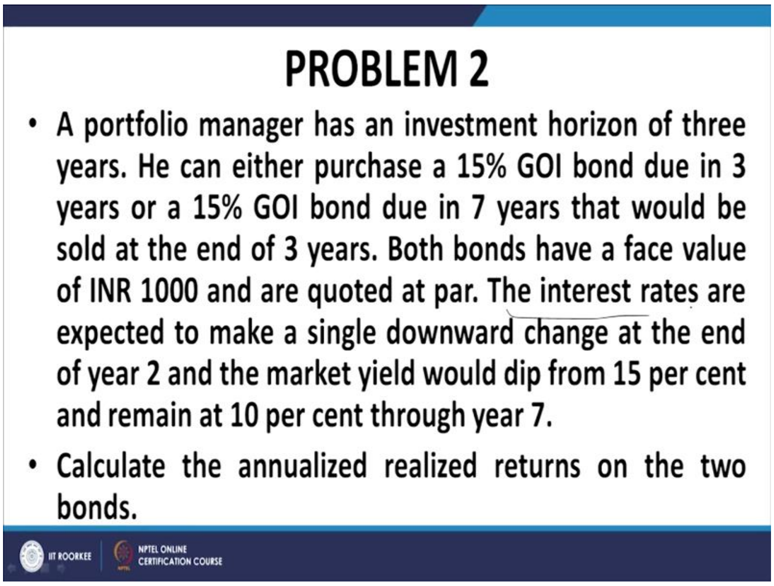

Let us do an example. A portfolio manager has an investment horizon of 3 years. He can either purchase a 15% p.a. Government of India bond due for redemption in 3 years or a 15% Government of India bond due for redemption in 7 years. In the latter case, the bond would be sold at the end of 3 years i.e. at the end of the investment horizon. Both bonds have a face value of 1,,000 and are quoted at par. We assume that the coupon payments are annual for simplicity of exposition. Now, interest rates are expected to make a single downward change at the end of year 2 whence the market yield would dip from 15% p.a. to 10% p.a. through to year 7. So, for 2 years the market interest rate would remain at their present value of 15% p.a. (Because the bonds are being quoted at par and they are 15% p.a. bonds, so clearly the market rates have to equal the coupon rates of 15% p.a.) and thereafter fall to 10% p.a.

The investors holding period is 3 years. So the coupons that the investor would receive at the end of the first year & the second year from either bond of 150 each would be reinvestable at the same rates in either case for two years & one year respectively. Hence, the discrimination between the bonds would manifest itself as the relative magnitude of the liquidation proceeds at the end of the third year i.e. on the date of exiting of the investment at the end of the holding period. Since bond A has a term to maturity of 3 years, the maturity of the bond coincides with the end of the holding period. Hence, it will be redeemed by the issuer at tace value of 1,000. However, bond B will has a remaining term to maturity of four years when the investor would liquidate the bond. Hence, it would need to be sold in the market at the end of year 3 to exit the investment. Now, it is projected that the interest rates would fall from 15% p.a. to 10% p.a., two years from now. Thus, the rate prevailing at the end of the investment horizon would be 10% p.a. and not 15% p.a. Becauuse the coupon rate is 15%

r.a., this bond (B) would be quoting above face value. It follows that B is the better investment.

Now, how do we work this out? How do we work out the price? We work out the price by discounting the remaining cash flows from the bond. Let us say, we want to work out the price of the bond B at the end of the 3 year holding period. This would simply be equal to the present value of all future cash flows, all the remaining cash flows.

What are the remaining cash flows? They are the coupon payments at the end of year 4, year 5, year 6 & year 7 and the redemption proceeds at par at the end of year 7. All these cash flows at the end of the fourth, fifth, sixth year of 150 and 1150 at end of year 7 would be discounted at the now prevailing interest rate which is 10% p.a. Clearly we will get a figure which is greater than 1,000. So, what does this imply? It implies that if we sell the bond B in the market at the end of three years, we get a price which is higher than the face value of the bond. However, as far as the bond A is concerned, because the investment horizon is coinciding with the life of the bond, we will simply get the redemption value of 1,000. So, without any analysis, we can infer that the bond B is going to give us a higher realized yield or annualized realized yield compared to the bond A over the holding period.

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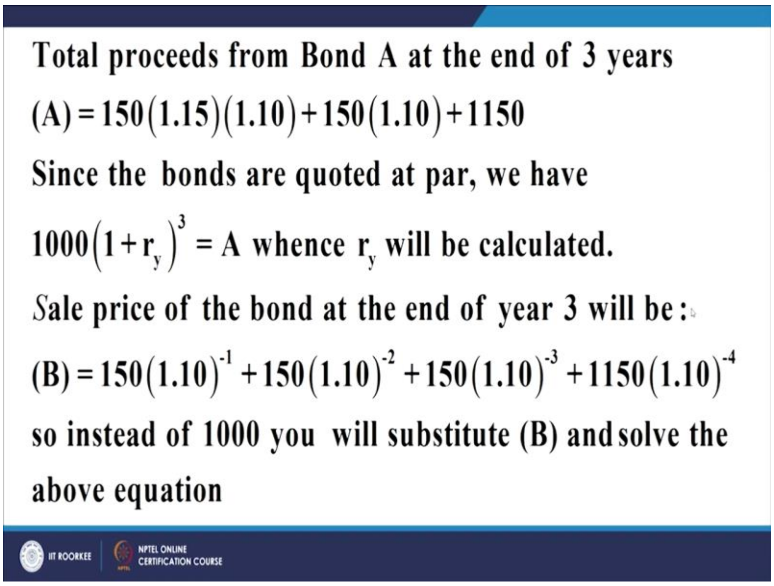

The above slide explains the procedure which technically we should follow.

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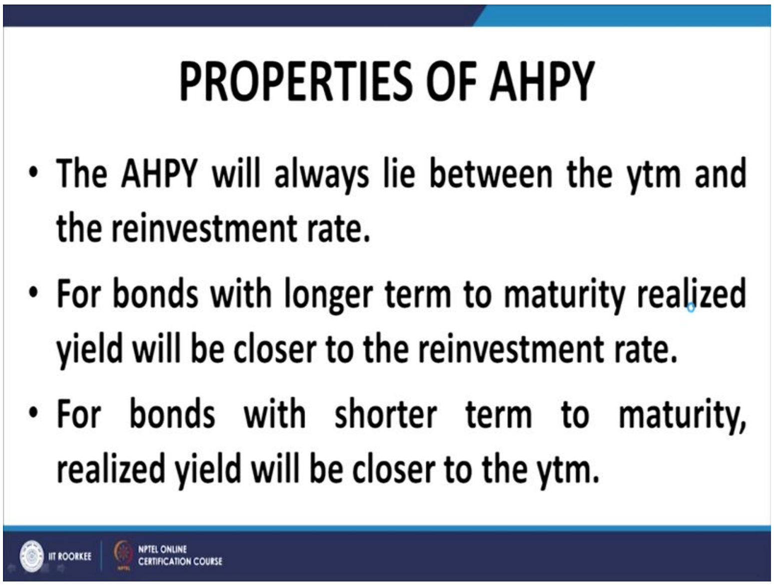

Now I take up the properties of annualized holding period yield. The annualized holding period yield will always lie between the YTM and the reinvestment rate. For bonds with longer term to maturity, the realized yield will be closer to the reinvestment rate. For bonds with shorter terms to maturity, the realized yield would be closer to the YTM of the bond. Let me repeat, for bonds with longer term to maturity i.e. large number of coupon payments remaining, the annualized holding period yield would be closer to the reinvestment rate and for bonds which have a short period to maturity and hence, lesser coupon payments remaining, the annualized holding period yield would be closer to the YTM.

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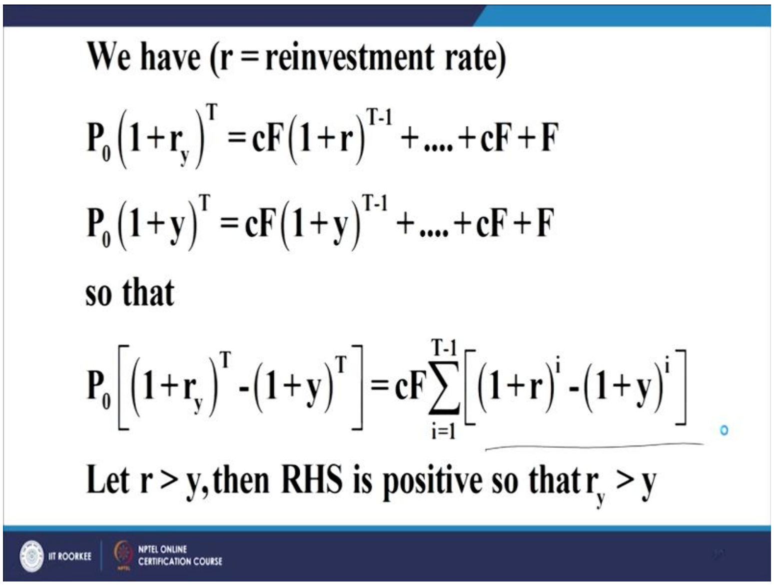

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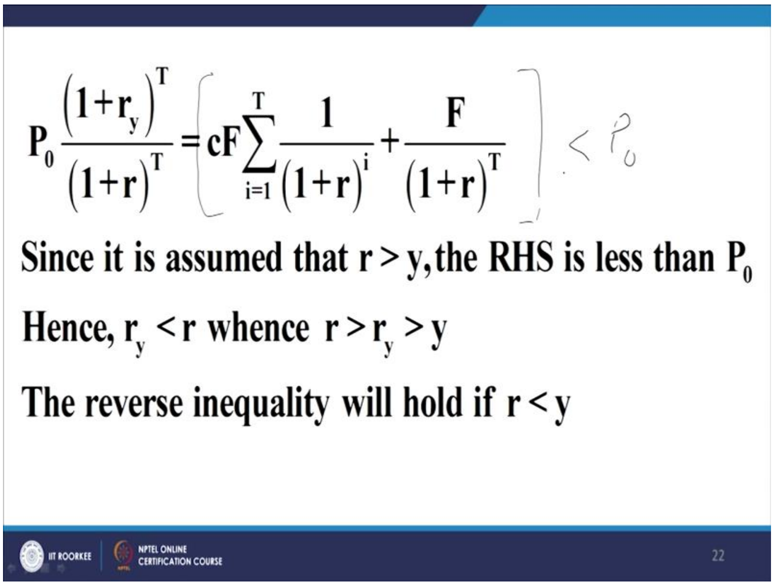

The proof is quite simple and explained in the above slides. So, we have now established that if the reinvestment rate r>y (YTM), then r>r_y>y. In other words, the realized yield r_y is sandwiched between the reinvestment rate and the YTM as mentioned in the properties.

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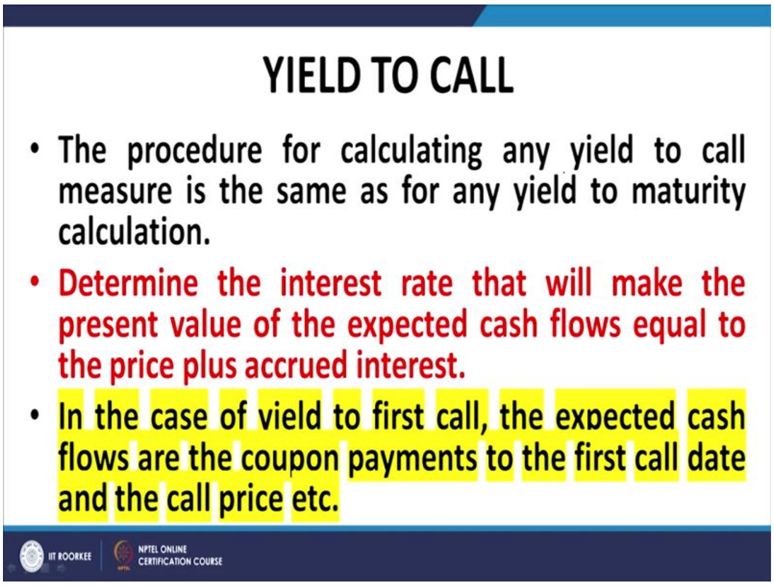

Now, yield to call, but before I talk about yield to call, let us understand what we mean by a callability option embedded in the bond. Now, it may so happen that the issuer of the bond has a perception that the interest rates may change to his favour i.e. the interest rates may decline some where down the line during the term of a bond. As a result of which, if he could get an opportunity to call back or buyback the bonds from the bondholders, then he may issue fresh instruments at a lower interest rate. This right retained by the issuer to buyback the bonds on terms stipulated in the issue document is called a call option. A call option is an option, choice, discretion which is vested in the holder of the option (which in this case is the issuer of the security) that he can buy the underlying instrument at a price which is predetermined. Now the price at which the call option can be exercised would be mentioned in the contract of issue.

We cannot, obviously, get up one fine morning, and say okay, I will buy back the issued bonds from the holders at this particular price and the investors be obliged to sell back the bonds. We have to specify all the conditions relating to the call option as part of the contract of issue under which these bonds are issued in the first place. All terms including, in particular, the buyback price under the option & the timing of the buyback must necessarily be madde known to the investors upfront when the bond issue is made. Bonds that have an underlying call option embedded in them, whereby the issuer of the instrument can, on the terms which are specified in the contract of issue, call back the bonds from the market,are said to be callable. So, call options can be vested in the contract of issue. The terms on which the call can be exercised, particular the exercise price at which the call may be exercised as well as the timing at which the call can be exercised or if there are more than one calls embedded in a bond, the exercise prices & timings at which the various calls can be exercised must be mentioned upfront at the time the bond issue is made.

Now how do we calculate the yield to call. Recall that yield to maturity assumes that we are holding the bond to maturity. Thereby we work out the yield on the instrument. Now, when we work out the yield to call, the process is absolutely similar. But instead of using the redemption value and the term to maturity, what we use is the assumption that the call is exercised by the issuer of the bond. Assuming that the issuer of the bond exercises the call at the exercise price and on the point in time at which the call is exercisable, we work out the yield on the bond. That yield is called the yield to call. In other words, we substitute the redemption value of the bond and the term to maturity of the bond by the exercise price of the call and the timing at which the call can to be exercised and thereby we work out a figure in absolutely similar manner and using the same formula as the YTM. The new YTM which is returned is called the yield to call. ***Stated simply, the yield to call is the yield on an instrument calculated on the assumption that the issuer of the exercises the embedded call option. Putting it explicitly, the yield to call is the discount rate at which the future cash flows emanating from the bond assuming that the call is exercised equal the present market price of the bond. The important part is, "assuming that the call is exercised". Now, we do not hold the bond to maturity. We hold the bond up to the call date and we also use***

the exercise price at which the call it exercisable by the issuer of the bond as the redemption value. So, in the case of the yield to first call the expected cash flows to the first call date and the call price etc. are used as I mentioned just now.

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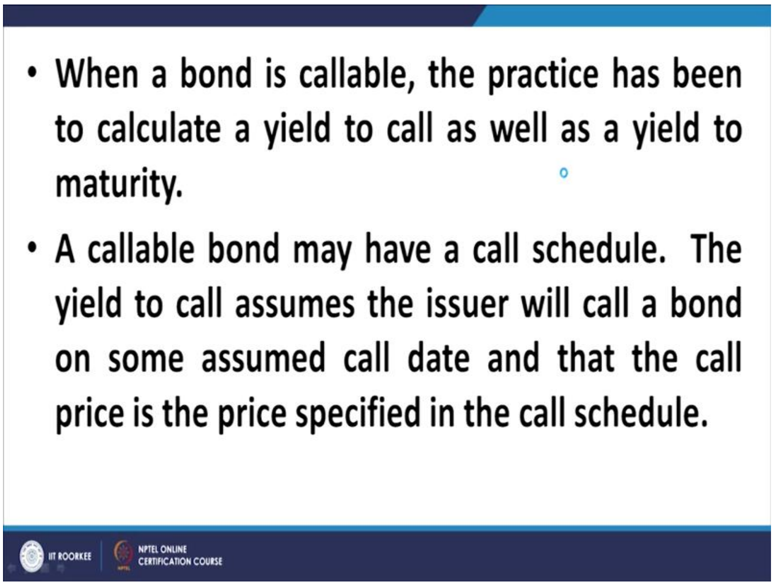

When a bond is callable, the practice is to calculate the YTM as well as a yield to call assuming that the call is exercised. A callable bond may have a call schedule. I mentioned just now that we can have a number of call optiuons embedded in a bond exercisable at different points in time say say t=6 months, 1 year etc. The issuer of the bond has the discretion to call back these bonds at prices which is mentioned in the contract of issue at any of these points in time. The exercise prices may also be different, the exercise price of the call exercisable at t=6 months may be different from that at t=1 year and so on. So, a callable bond may have a call schedule. A yield to call assumes that the issuer will call a bond on some assumed call date and the call price at the price specified in the call schedule.

Typically, investors calculate a yield to first call and a yield to next call. The yield to first call is computed for an issue that is not currently callable, while the yield to next call is computed for an issue that is currently callable. In other words, if the point in time at which the first call is made has expired and therefore, the bond is callable under the first call, but it is not callable under the second call, then we can work out the yield to next call, instead of working out the yield to first call.

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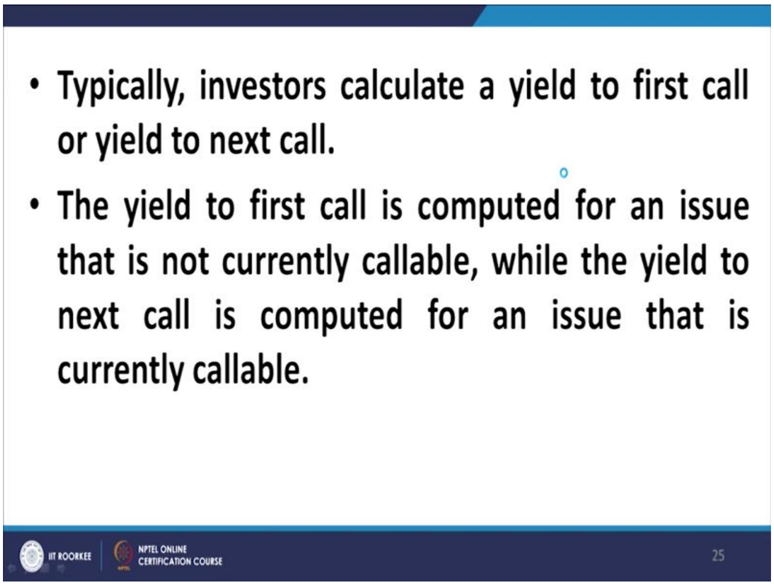

Similar to the yield to call we can work out the yield to put. What is a put option? Put option is the right to sell.

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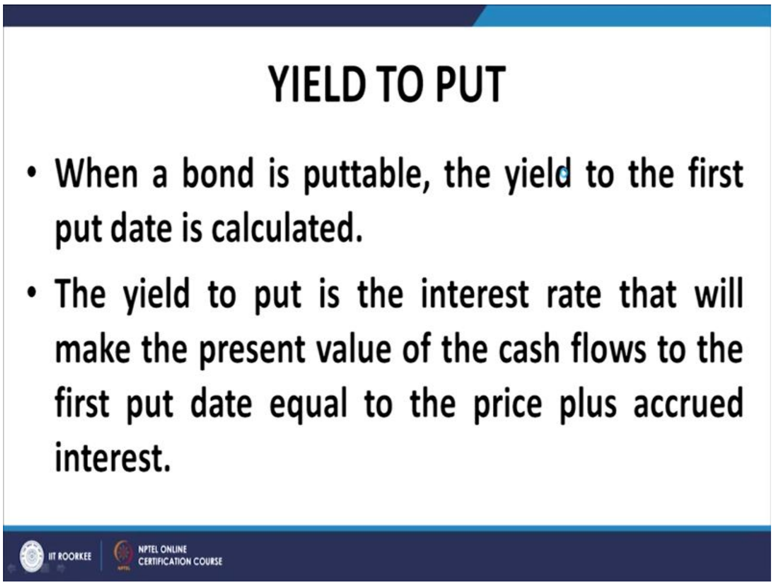

So, if a bond is embedded with a put option, then there exists a feature that gives the investor a right to sell the bond back to the issuer at a predetermined price on a predetermined date. The predetermined price again is the exercise price at which the investor can exercise the discretion i.e. exercise the right to return the bond to the issuer. So, if the bond has a put option feature, then we can work out a yield to put option in the same manner as we work out the yield to call, that is, instead of using the maturity and the redemption value of the bond in the YTM formula, we use the point in time at which the put option can be exercised and the exercise price of the put option and work up the yield accordingly.

Now, we come to clean and dirty price.

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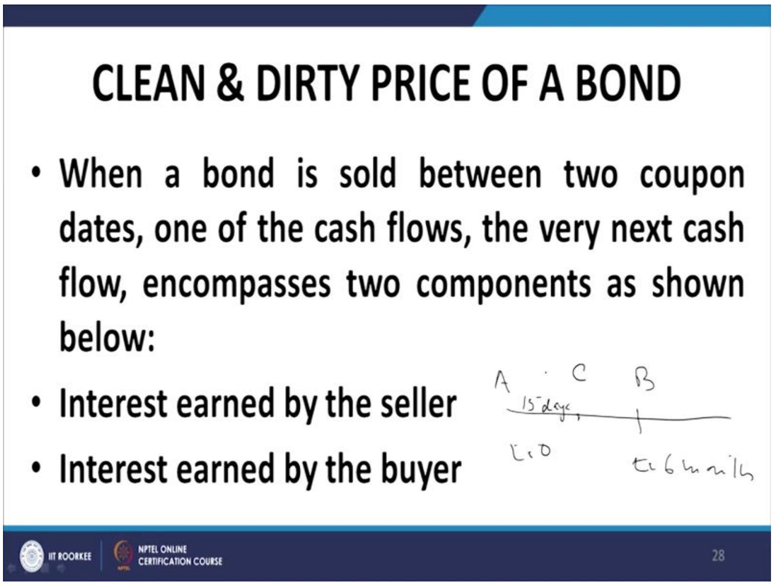

Now this is a very important concept. Let me explain it briefly. I shall take an example of this in the next lecture. Let us say, today is t=0 (A) and today a particular bond has made a coupon payment. The next coupon payment is say at t=6 months (B). Now we move forward in time from t=0. Say at t=1 month (C) (or any date in between t=0 & t=6 months i.e. between the two consecutive coupon dates) I decide to liquidate my holding of the bond. The party who buys the bond at C, will obviously get it transferred in his name. Consequently, the issuer will make the coupon payment at B to this party and not to me because after registering the sale, the buyer's name has replaced my name and his name now appears in the Register of Bondholders of the issuer.

But I have held the bond for the period AC i.e. upto the point C since the last coupon payment. Hence, I need to be paid interest for the period AC. The practice is that this interest is paid by the buyer of the bond tome as an add-on to the transaction price upfront i.e. together with the transaction price. This is called the dirty price of the bond. The buyer will get this amount reimbursed from the issuer at the point B since the issuer will pay the buyer the interest for the full period AB which includes the interest for the period AC for which I have held the bond and for which the buyer has already paid out the interest to me in the transaction price. So, this is the issue that we will address in the next lecture. Thank you.