

## MA-374 Lab-11

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### Question 1:

- In the Vasicek Model the risk neutral dynamics of  $r$  can be expressed as -

$$dr = (b - ar)dt + \sigma dW$$

- On comparing with the model we get  $a = \beta$  and  $b = \beta u$ .
- Price of the bond is calculated using following formulae -

$$B(t, T) = \frac{1 - e^{-a(T-t)}}{a}$$

$$A(t, T) = \frac{(B(t, T) - T + t)(ab - \frac{\sigma^2}{2})}{a^2} - \frac{\sigma^2 B^2(t, T)}{4a}$$

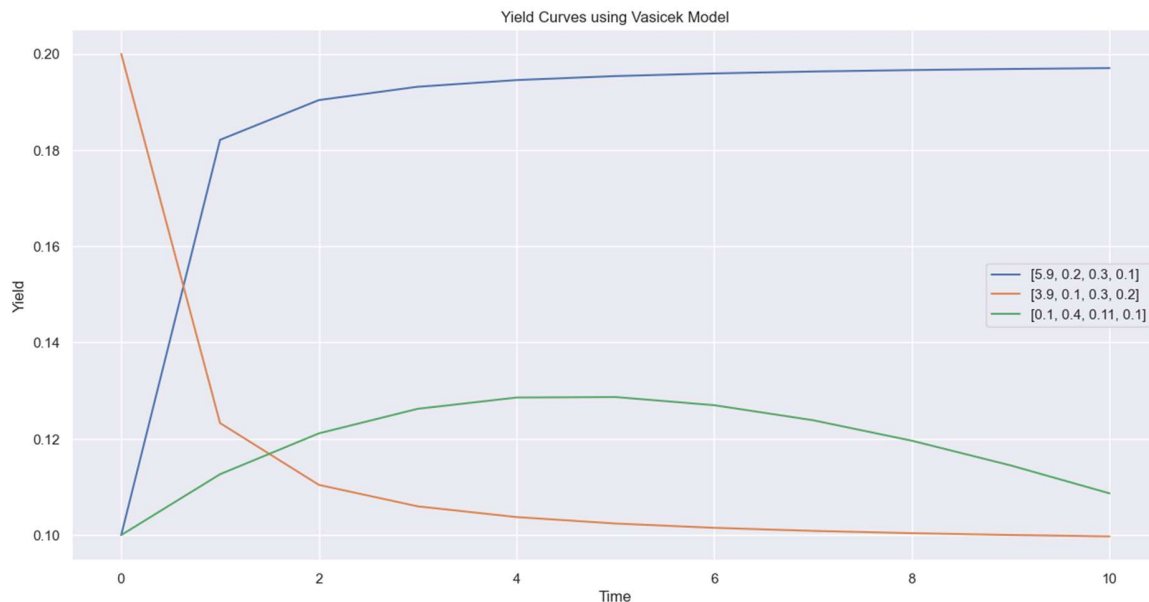
$$\rho(t, T) = e^{A(t, T) - B(t, T)r(t)}$$

- Yield can be calculated from the price using following formula-

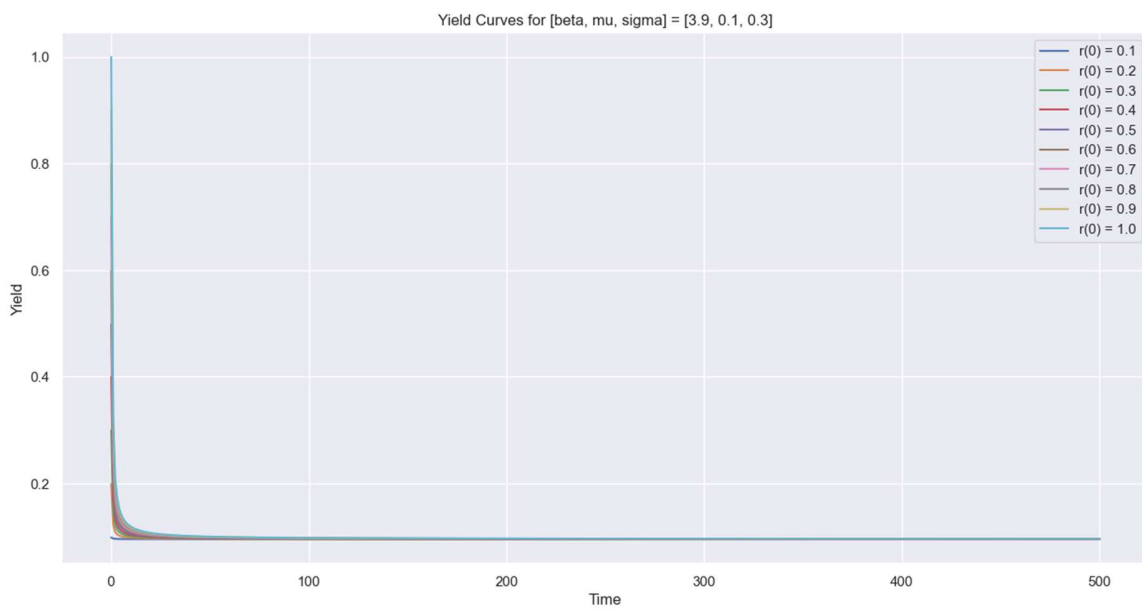
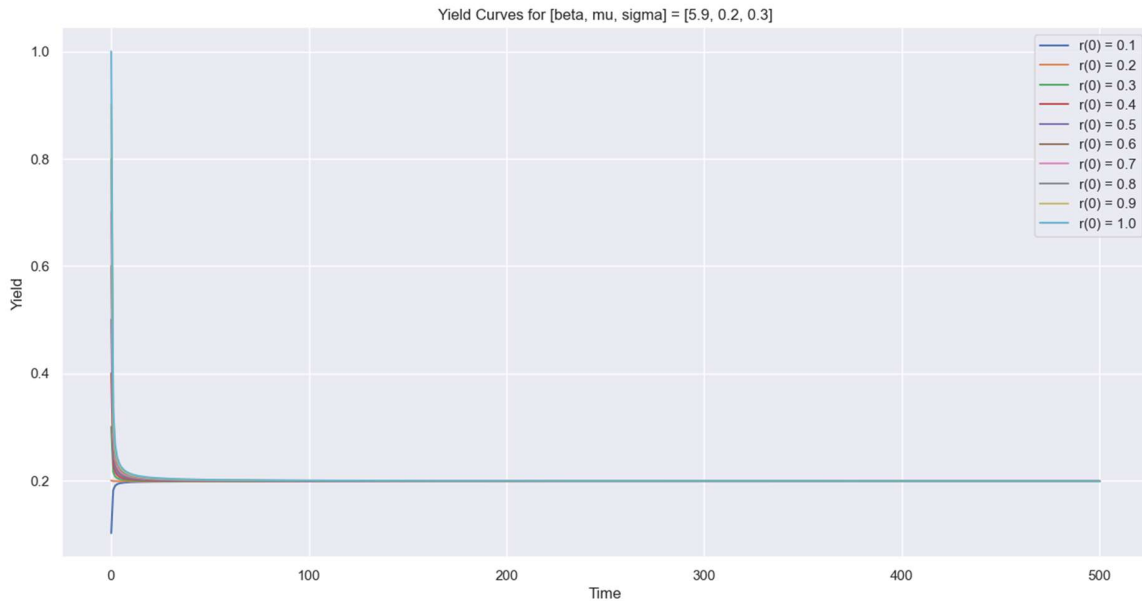
$$Yield = \frac{-\log(p(t, T))}{T - t}$$

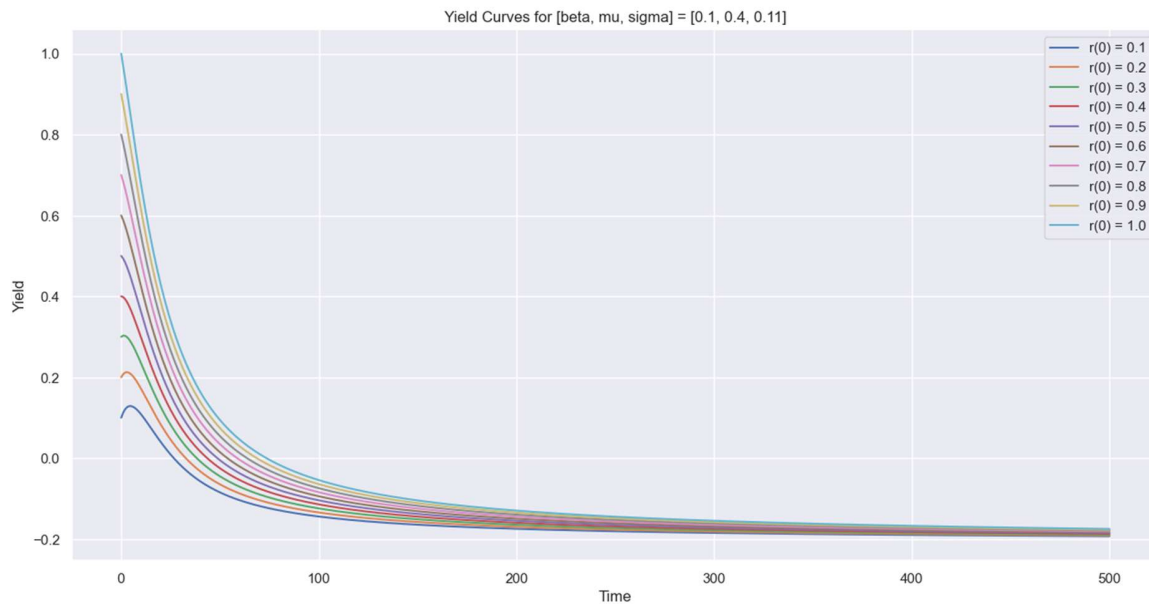
- $t = 0$  in our case.

Term structure for the given parameters is plotted using 10 time units.



Now, yield curves versus maturity up to 500 time units for 10 different values of  $r(0)$  are plotted for all the three sets of parameters.





### Observations :

- For higher  $r(0)$ , yield is higher
- Yield converges to a limit for all the parameters.
- Yield can increase or decrease with time to maturity. It depends on the prediction made using the current parameters about the future interest rates.

### Question 2:

- In the CIR(Cox-Ingersoll-Ross) model the risk neutral dynamics of  $r$  can be expressed as -

$$dr = a(b - r)dt + \sigma\sqrt{r}dW$$

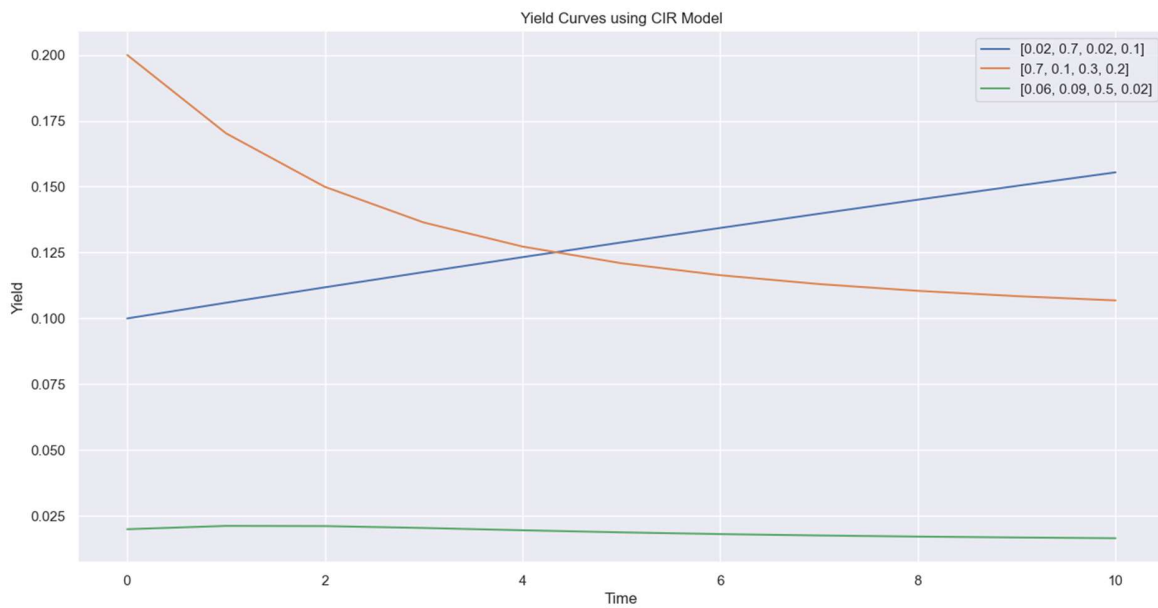
- On comparing with the model we get  $a = \beta$  and  $b = \mu$ .
- Price of the bond is calculated using following formulas -

- Yield can be calculated from the price using following formula -

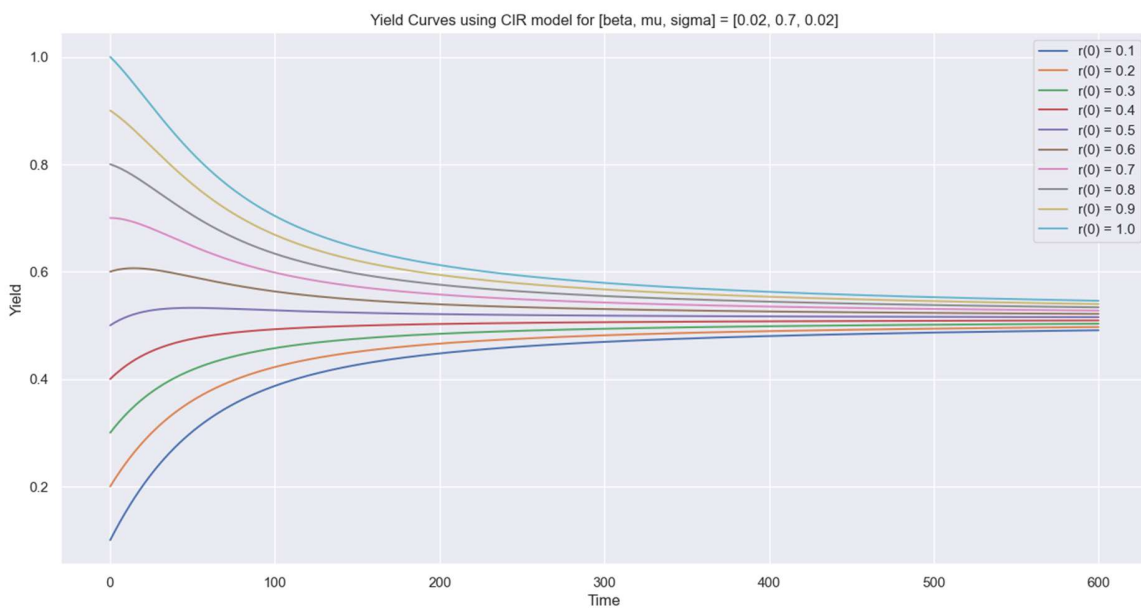
$$Yield = \frac{-\log(p(t, T))}{T - t}$$

- $t = 0$  in our case.

Term structure for the given parameters is plotted using 10 time units.



Now, yield curves versus maturity up to 600 time units for  $r(0) = 0.1:0.1:1$  is plotted for  $[\text{beta}, \mu, \text{sigma}] = [0.02, 0.7, 0.02]$ .



### Observations :

- For higher  $r(0)$ , yield is higher.
- Yield converges to a limit.
- Yield can increase or decrease with time to maturity. It depends on the prediction made using the current parameters about the future interest rates.