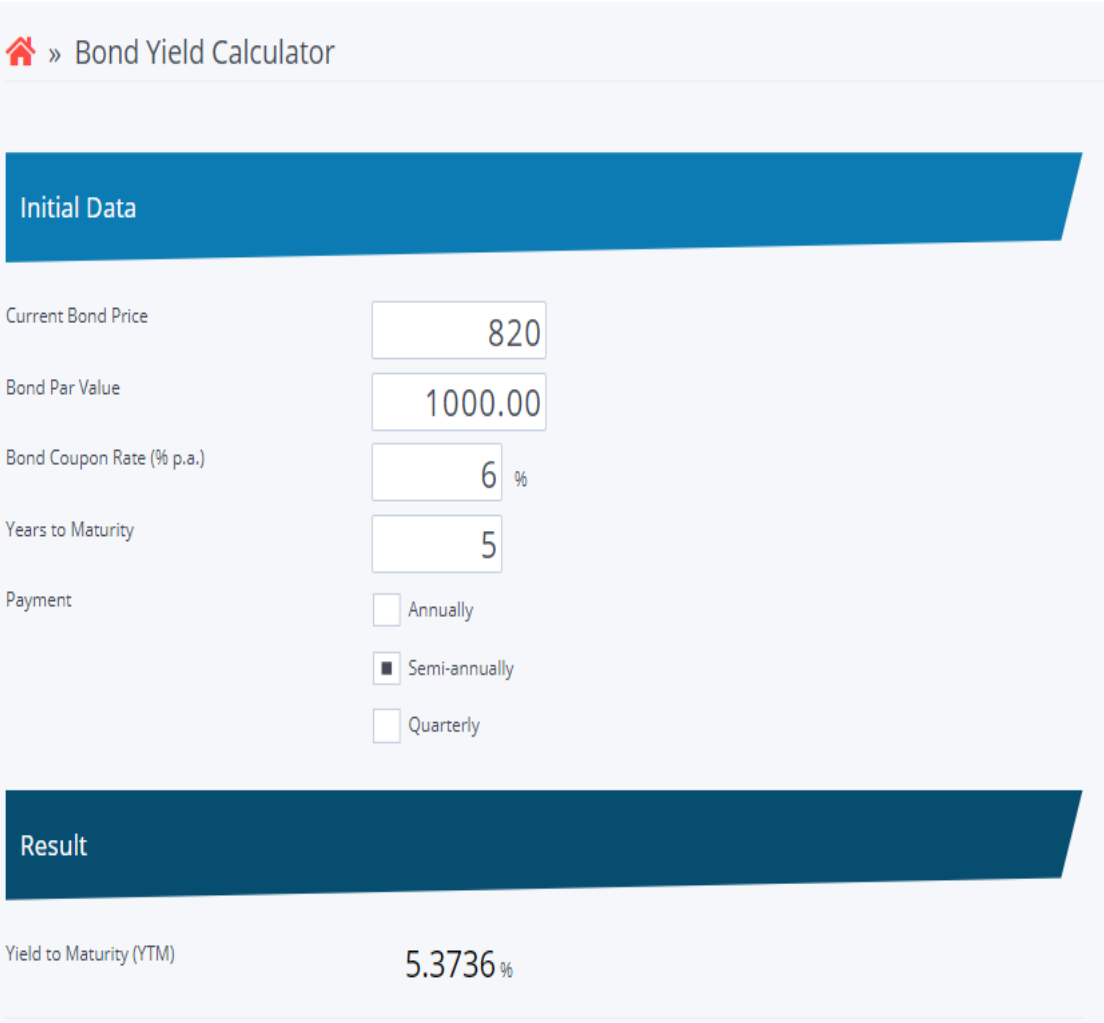
In [11]:
```
# ytm calculator
decimal.getcontext().rounding = "ROUND_HALF_UP"

current_bond_price = int(input('Current Bond Price: '))
bond_par_value = int(input('Bond Par Value: '))
rate = 0.01 * int(input('Bond Coupon Rate(%): '))
years = int(input('Years to Maturity: '))
payment = int(input('Payments a yaer: '))

nper = years * payment  # 期數
lst = [-current_bond_price] + [bond_par_value*rate/payment]*(nper-1) + [bond_par

ytm = Decimal(sp.irr(lst)*100).quantize(Decimal('0.0000'))

print('Yield to Maturity(YTM) = {}%'.format(ytm), sep ='')
```

```
Current Bond Price: 820
Bond Par Value: 1000
Bond Coupon Rate(%): 6
Years to Maturity: 5
Payments a yaer: 2
Yield to Maturity(YTM) = 5.3736%
```

In [12]:
```
num = 0
for i in range(1,11):
    num += lst[i]/(1+0.05376)**i
num = Decimal(num).quantize(Decimal('0'))
print(num)
```

```
820
```



參考網頁ytm計算器的計算公式，code裡有用到一個套件scipy。接著驗算現值pv

例子說明

```
sp.irr([-820, 30.0, 30.0, 30.0, 30.0, 30.0, 30.0, 30.0, 30.0, 30.0, 1030.0])
```

期初投入820，每期拿回利息=30，最後一期拿回本金+利息=1030

820 = 30/(1 + 0.05376) + 30/(1 + 0.05376)^2 + ... + 1030/(1 + 0.05376)^10

Discrete :

$$P_t = \frac{1}{(1+y_t)^t}$$

$$P_t^{-\frac{1}{t}} = 1 + y_t$$

$$\Rightarrow y_t = P_t^{-\frac{1}{t}} - 1$$

Continuous :

$$P_t = e^{-r_t \cdot t}$$

$$\Rightarrow r_t = -\frac{1}{t} \ln P_t$$

Discrete :

① given spot rate

$$(1+f_{\hat{i}j})^{j-\hat{i}} = \frac{(1+y_j)^j}{(1+y_{\hat{i}})^{\hat{i}}}$$

$$\Rightarrow f_{\hat{i}j} = \left(\frac{(1+y_j)^j}{(1+y_{\hat{i}})^{\hat{i}}}\right)^{\frac{1}{j-\hat{i}}} - 1$$

② given price

$$(1+f_{\hat{i}j})^{j-\hat{i}} = \frac{(1+y_j)^j}{(1+y_{\hat{i}})^{\hat{i}}} = \frac{P_{\hat{i}}}{P_j}$$

$$\Rightarrow f_{\hat{i}j} = \left(\frac{P_{\hat{i}}}{P_j}\right)^{\frac{1}{j-\hat{i}}} - 1$$

Continuous :

① given spot rate

$$e^{F_{\hat{i}j} \cdot (j-\hat{i})} = \frac{e^{-r_{\hat{i}} \cdot \hat{i}}}{e^{-r_j \cdot j}}$$

$$e^{F_{\hat{i}j}(j-\hat{i})} = e^{r_j \cdot j - r_{\hat{i}} \cdot \hat{i}}$$

$$\Rightarrow F_{\hat{i}j} = \frac{1}{j-\hat{i}} (r_j \cdot j - r_{\hat{i}} \cdot \hat{i})$$

② given price

$$e^{F_{ij} \cdot (j-\hat{i})} = \frac{P_{\hat{i}}}{P_j}$$

$$\Rightarrow F_{\hat{i}j} = \frac{1}{j-\hat{i}} \cdot \ln \frac{P_{\hat{i}}}{P_j}$$

Spot rate & Forward rate公式推導

In [21]:
```
# spot rate calculator
decimal.getcontext().rounding = "ROUND_HALF_UP"

t = int(input('Duration of spot rate (years): '))
p = float(input('Price of {} year unit zero-coupon bond: '.format(t)))

y = p ** (-1/t) -1
Y = (-1/t) * math.log(p)

y = Decimal(100*y).quantize(Decimal('0.00'))
Y = Decimal(100*Y).quantize(Decimal('0.00'))

print('{} year spot rate of interest: '.format(t) + str(y) + '%')
print('{} year spot force of interest: '.format(t) + str(Y) + '%')
```

```
Duration of spot rate (years): 4
Price of 4 year unit zero-coupon bond: 0.85
4 year spot rate of interest: 4.15%
4 year spot force of interest: 4.06%
```

Enter the following details:

Duration of spot rate: 4 (years)

Price of 4 year unit zero-coupon bond: 0.85

CALCULATE CLEAR

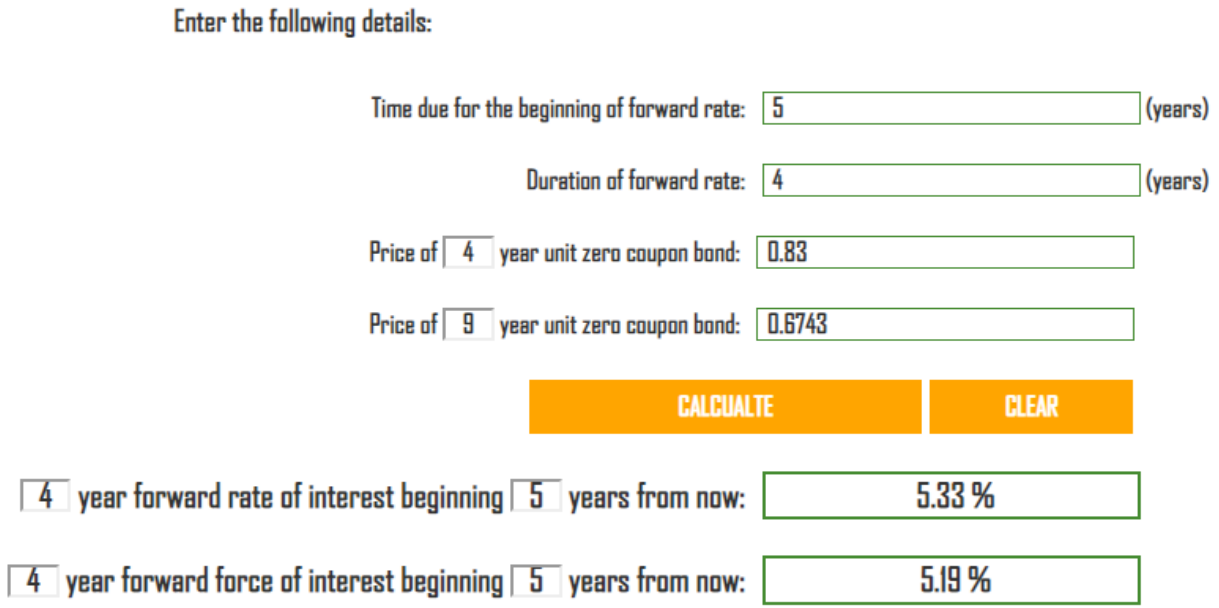
4 year spot rate of interest: 4.15 %

4 year spot force of interest: 4.06 %

程式碼驗證spot rate

In [14]:
```
# forward rate calculator
decimal.getcontext().rounding = "ROUND_HALF_UP"

t = int(input('Time due for the beginning of forward rate (years): '))
r = int(input('Duration of forward rate (years): '))
Pt = float(input('Price of {} year unit zero coupon bond: '.format(t)))
Pt_r = float(input('Price of {} year unit zero coupon bond: '.format(t+r)))

y = (Pt/Pt_r)**(1/r) - 1
Y = (1/r) * math.log(Pt/Pt_r)

y = Decimal(100*y).quantize(Decimal('0.00'))
Y = Decimal(100*Y).quantize(Decimal('0.00'))

print('{} year forward rate of interest beginning {} years from now: '.format(r,t) + str(y) + '%')
print('{} year forward force of interest beginning {} years from now: '.format(r,t) + str(Y) + '%')
```

```
Time due for the beginning of forward rate (years): 5
Duration of forward rate (years): 4
Price of 5 year unit zero coupon bond: 0.83
Price of 9 year unit zero coupon bond: 0.6743
4 year forward rate of interest beginning 5 years from now: 5.33%
4 year forward force of interest beginning 5 years from now: 5.19%
```



程式碼驗證 forward rate