BOOK 4 FORMULAE

Net Present Value

$$NPV = \sum_{t=1}^{n} \frac{CF_t}{(1+r)^t} - \text{Outlay}$$

where
CF_t = after-tax cash flow at time, t.
r = required rate of return for the investment. This is the firm's cost of capital adjusted for the risk inherent in the project.
Outlay = investment cash outflow at t = 0.

Internal Rate of Return

$$\sum_{t=1}^{n} \frac{CF_t}{(1+IRR)^t} = \text{Outlay} \qquad \sum_{t=1}^{n} \frac{CF_t}{(1+IRR)^t} - \text{Outlay} = 0$$

Average Accounting Rate of Return (AAR)

$$AAR = \frac{\text{Average net income}}{\text{Average book value}}$$

Profitability Index

$$PI = \frac{\text{PV of future cash flows}}{\text{Initial investment}} = 1 + \frac{NPV}{\text{Initial investment}}$$

Weighted Average Cost of Capital

$$WACC = (w_d)(r_d)(1-t) + (w_p)(r_p) + (w_e)(r_e)$$

Where:
w_d = Proportion of debt that the company uses when it raises new funds
r_d = Before-tax marginal cost of debt
t = Company's marginal tax rate
w_p = Proportion of preferred stock that the company uses when it raises new funds
r_p = Marginal cost of preferred stock
w_e = Proportion of equity that the company uses when it raises new funds
r_e = Marginal cost of equity

Weight of Debt

$$\frac{D/E}{1+D/E} = \frac{D}{D+E} = w_d$$

$$w_d + w_e = 1$$

Bond Price

$$P_0 = \left[\sum_{t=1}^{n} \frac{PMT}{\left(1+\frac{r_d}{2}\right)^t}\right] + \frac{FV}{\left(1+\frac{r_d}{2}\right)^n}$$

where:
P_0 = current market price of the bond.
PMT_t = interest payment in period t.
r_d = yield to maturity on BEY basis.
n = number of periods remaining to maturity.
FV = Par or maturity value of the bond.

Valuation of Preferred Stock

$$V_p = D_p / r_p$$

where:
V_p = current value (price) of preferred stock..
D_p = preferred stock dividend per share.
r_p = cost of preferred stock.

Expected Rreturn on a Stock (CAPM)

$$r_e = R_F + \beta_i[E(R_M) - R_F]$$

where
$[E(R_M) - R_F]$ = Equity risk premium.
R_M = Expected return on the market.
β_i = Beta of stock . Beta measures the sensitivity of the stock's returns to changes in market returns.
R_F = Risk-free rate.
r_e = Expected return on stock (cost of equity)

Dividend Discount Model

$$P_0 = \frac{D_1}{r_e - g}$$

where:
P_0 = current market value of the security.
D_1= next year's dividend.
r_e = required rate of return on common equity.
g = the firm's expected constant growth rate of dividends.

Rearranging the above equation gives us a formula to calculate the required return on equity:

Sustainable Growth Rate

$$r_e = \frac{D_1}{P_0} + g$$

$$g = \left(1 - \frac{D}{EPS}\right) \times (ROE)$$

Where (1 - (D/EPS)) = Earnings retention rate

Asset Beta

$$\beta_{ASSET} = \beta_{EQUITY}\left[\frac{1}{1 + \left((1-t)\frac{D}{E}\right)}\right]$$

Project Beta

$$\beta_{PROJECT} = \beta_{ASSET}\left[1 + \left((1-t)\frac{D}{E}\right)\right]$$

Country Risk Premium

$$r_e = R_F + \beta\,[E(R_M) - R_F + CRP]$$

$$\text{Country risk premium} = \text{Sovereign yield spread} \times \frac{\text{Annualized standard deviation of equity index}}{\text{Annualized standard deviation of sovereign bond market in terms of the developed market currency}}$$

Break Point

$$\text{Break point} = \frac{\text{Amount of capital at which a component's cost of capital changes}}{\text{Proportion of new capital raised from the component}}$$

Current Ratio

$$\text{Current Ratio} = \frac{\text{current assets}}{\text{current liabilities}}$$

Quick Ratio

$$\text{Quick Ratio} = \frac{\text{cash} + \text{short term marketable investments} + \text{receivables}}{\text{Current liabilities}}$$

Current Ratio

$$\text{Accounts receivable turnover} = \frac{\text{Credit sales}}{\text{Average receivables}}$$

Number of Days of Receivables

$$\text{Number of days of receivables} = \frac{\text{Accounts receivable}}{\text{Average day's sales on credit}} = \frac{\text{Accounts receivable}}{\text{Sales on credit / 365}}$$

Inventory Turnover

$$\text{Inventory turnover} = \frac{\text{Cost of goods sold}}{\text{Average inventory}}$$

Number of Days of Inventory

$$\text{Number of days of inventory} = \frac{\text{Inventory}}{\text{Average day's cost of goods sold}} = \frac{\text{Inventory}}{\text{Cost of goods sold / 365}}$$

$$= \frac{365}{\text{Inventory turnover}}$$

Payables Turnover

$$\text{Payables turnover} = \frac{\text{Purchases}}{\text{Average trade payables}}$$

Number of Days of Payables

$$\text{Number of days of payables} = \frac{\text{Accounts payables}}{\text{Average day's purchases}} = \frac{\text{Accounts payables}}{\text{Purchases/365}} = \frac{365}{\text{Payables turnover}}$$

Cost of Goods Sold

Purchases = Ending inventory + COGS - Beginning inventory

Operating Cycle

Operating cycle = Number of days of inventory + Number of days of receivables

Net Operating Cycle

Net operating cycle = Number of days of inventory + Number of days of receivables
-Number of days of payables

Money Market Yield

$$\text{Money market yield} = \left(\frac{\text{Face value - price}}{\text{Price}}\right) \times \left(\frac{360}{\text{Days}}\right) = \text{Holding period yield} \times \left(\frac{360}{\text{Days}}\right)$$

Bond Equalent Yield

$$\text{Bond equivalent yield} = \left(\frac{\text{Face value - price}}{\text{Price}}\right) \times \left(\frac{365}{\text{Days}}\right) = \text{Holding period yield} \times \left(\frac{365}{\text{Days}}\right)$$

Discount Basis Yield

$$\text{Discount basis yield} = \left(\frac{\text{Face value - price}}{\text{Face value}}\right) \times \left(\frac{360}{\text{Days}}\right) = \%\ \text{discount} \times \left(\frac{360}{\text{Days}}\right)$$

Where:

$$\%\ \text{Discount} = \frac{\text{Face value - Price}}{\text{Price}}$$

Implicit Rate

$$\text{Implicit rate} = \text{Cost of trade credit} = \left(1 + \frac{\text{Discount}}{1 - \text{Discount}}\right)^{\left(365 / \text{Number of days beyond discount period}\right)} - 1$$

Line of Credit Cost

$$\text{Line of credit cost} = \frac{\text{Interest} + \text{Commitment fee}}{\text{Loan amount}}$$

Banker's Acceptance Cost

$$\text{Banker's acceptance cost} = \frac{\text{Interest}}{\text{Net proceeds}} = \frac{\text{Interest}}{\text{Loan amount - Interest}}$$

Cost of Commercial Paper

$$\frac{\text{Interest} + \text{Dealer's comission} + \text{Backup costs}}{\text{Loan amount - Interest}}$$

Return on Equity

$$\text{ROE} = \frac{\text{Net income}}{\text{Average total equity}}$$

$$\text{ROE} = \frac{\text{Net income}}{\text{Average total assets}} \times \frac{\text{Average total assets}}{\text{Average shareholders' equity}}$$

$$\text{ROE} = \frac{\text{Net income}}{\text{Revenue}} \times \frac{\text{Revenue}}{\text{Average total assets}} \times \frac{\text{Average total assets}}{\text{Average shareholders' equity}}$$

Expected Return on 'n' Asset Portfolio

$$E(R) = \sum_{i=1}^{n} P_i R_i = P_1 R_1 + P_2 R_2 + P_n R_n$$

where:
P_i = probability that state i will occur
R_i = asset return in state i

Expected Return on 2 Asset Portfolio

$$E(R_p) = w_1 E(R_1) + w_2 E(R_2)$$

where:
$E(R_1)$ = expected return on Asset 1
$E(R_2)$ = expected return on Asset 2
w_1 = Percentage of portfolio invested in Asset 1
w_2 = Percentage of portfolio invested in Asset 2

Covariance - Probability Model

$$Cov_{1,2} = \sum_{i=1}^{n} P_i \left\{[R_{i,1} - E(R_1)][R_{i,2} - E(R_2)]\right\}$$

where:
$R_{i,1}$ = return on Asset 1 in state i
$R_{i,2}$ = return on Asset 2 in state i
P_i = probability of state i actually occurring
$E(R_1)$ = expected return on Asset 1
$E(R_2)$ = expected return on Asset 2

Covariance - Historical Data

$$Cov_{1,2} = \sum_{t=1}^{n} \left\{[R_{t,1} - \overline{R}_1][R_{t,2} - \overline{R}_2]\right\} \Big/ (n-1)$$

where:
$R_{t,1}$ = return on Asset 1 in period t
$R_{t,2}$ = return on Asset 2 in period t
$\overline{R}_1$ = mean return on Asset 1
$\overline{R}_2$ = mean return on Asset 2
n = number of observations

Variance and Standard Deviation of Returns for an Individual Asset

$$\text{Variance} = \sigma^2 = \sum_{i=1}^{n} P_i [R_i - E(R)]^2$$

$$\text{Standard deviation} = \sigma = \sqrt{\sigma^2}$$

where:
R_i = return in state i
P_i = probability of state i occurring
$E(R)$ = expected return

Correlation

$$\rho_{1,2} = \frac{Cov_{1,2}}{(\sigma_1) \times (\sigma_2)}$$

Covariance in terms of Correlation

$$Cov_{1,2} = \rho_{1,2} \times (\sigma_1)(\sigma_2)$$

Standard Deviation of a Portfolio

$$\sigma_p = \sqrt{\sigma_p^2} = \sqrt{\sum_{i=1}^{n} w_i^2 \sigma_i^2 + \sum_{i=1}^{n} \sum_{j=1}^{n} w_i w_j Cov_{i,j}} \qquad i \neq j$$

Standard Deviation of a Portfolio Consisting of 2 Risky Assets

$$\sigma_p = \sqrt{w_1^2\sigma_1^2 + w_2^2\sigma_2^2 + 2w_1 w_2 \sigma_1 \sigma_2 \rho_{1,2}} \text{ or } \sqrt{w_1^2\sigma_1^2 + w_2^2\sigma_2^2 + 2w_1 w_2 Cov_{1,2}}$$

Standard Deviation of a Portfolio Consisting of 3 Risky Assets

$$\sigma_p = \sqrt{w_1^2\sigma_1^2 + w_2^2\sigma_2^2 + w_3^2\sigma_3^2 + 2w_1 w_2 Cov_{1,2} + 2w_2 w_3 Cov_{2,3} + 2w_3 w_1 Cov_{3,1}}$$

Expected Return for the Portfolio When the Risk-Free Asset is Added

$$E(R_p) = w_i\, E(R_i) + (1 - w_i)RFR \text{ or } E(R_p) = RFR + w_i[E(R_i) - RFR]$$

Return Stated in Terms of Risk OR CAPM

$$E(R_i) = RFR + \frac{Cov_{i,M}}{\sigma_M^2}(R_M - RFR)$$

$$E(R_i) = RFR + \beta_i(R_M - RFR)$$

Margin Call

$$\frac{P_0(\text{ 1- initial margin})}{(\text{1-maintenance margin})}$$

Price-Weighted Index

$$\text{Price-weighted index} = \frac{\text{sum of stock prices}}{\text{number of stocks in index adjusted for splits}}$$

Value-Weighted Index

$$\text{Index}_t = \frac{\Sigma P_t Q_t}{\Sigma P_b Q_b} \times \text{Beginning index value}$$

Abnormal Return

Abnormal return = Actual return – Expected/required return according to the SML

$$\text{abnormal return} = R_{actual} - R$$

$$\text{abnormal return} = R_{actual} - \{RFR + \beta_i [E(R_{mkt}) - RFR]\}$$

Value of Preferred Stock

$$\text{Preferred stock value} = \frac{D_p}{(1+k_p)^1} + \frac{D_p}{(1+k_p)^2} + \ldots + \frac{D_p}{(1+k_p)^\infty} = \frac{D_p}{k_p}$$

where:
k_p = required return on preferred stock.
D_p = preferred stock dividend.

Value of Common Stock

$$\text{Value} = \frac{D_1}{(1+k_e)^1} + \frac{D_2}{(1+k_e)^2} + \ldots + \frac{D_\infty}{(1+k_e)^\infty} = \sum_{t=1}^{n} \frac{D_t}{(1+k_e)^t}$$

One-Year Holding Period Dividend Discount Model (DDM)

$$\text{Value} = \frac{\text{dividend to be received}}{(1+k_e)^1} + \frac{\text{year-end price}}{(1+k_e)^1}$$

n-Year Holding Period DDM

$$V = \frac{D_1}{(1+k_e)^1} + \frac{D_2}{(1+k_e)^2} + \ldots + \frac{P_n}{(1+k_e)^n}$$

where:
P_n = Price at the end of n years.

Infinite Period DDM

$$PV_0 = \frac{D_0(1+g_c)^1}{(1+k_e)^1} + \frac{D_0(1+g_c)^2}{(1+k_e)^2} + \frac{D_0(1+g_c)^3}{(1+k_e)^3} + \ldots + \frac{D_0(1+g_c)^\infty}{(1+k_e)^\infty} = \frac{D_0(1+g_c)^1}{(k_e - g_c)^1} = \frac{D_1}{k_e - g_c}$$

Required Return or Cost of Equity

$$k_e = \frac{D_1}{PV_0} + g_c$$

Multiple-Period Valuation Model with a Period of Supernormal Growth

$$\text{Value} = \frac{D_1}{(1+k_e)^1} + \frac{D_2}{(1+k_e)^2} + \ldots + \frac{D_n}{(1+k_e)^n} + \frac{P_n}{(1+k_e)^n}$$

where:

$$P_n = \frac{D_{n+1}}{k_e - g_c}$$

D_n = Last dividend of the supernormal growth period
D_{n+1} = First dividend of the supernormal growth period

Price-to-Earnings Ratio

$$\frac{P_0}{E_1} = \frac{D_1 / E_1}{k_e - g_c}$$

Trailing P/E Ratio

$$\text{Trailing P/E} = \frac{\text{Market price of share}}{\text{Earnings for the past 4 quarters}}$$

Leading P/E Ratio

$$\text{Leading P/E} = \frac{\text{Market price of share}}{\text{Earnings over the next 4 quarters}}$$

Price-to-Book Value

$$\text{P/BV} = \frac{\text{Current market price of share}}{\text{Book value per share}}$$

$$\text{P/BV} = \frac{\text{Market value of common shareholders' equity}}{\text{Book value of common shareholders' equity}}$$

where:
Book value of common shareholders' equity = (total assets - total liabilities) - preferred stock

Price-to-Sales

$$\text{Price to sales ratio} = \frac{\text{Market price per share}}{\text{Net sales per share}}$$

$$\text{Price to sales ratio} = \frac{\text{Market value of equity}}{\text{Total net sales}}$$

Price-to-Cash Flow

$$\text{Price to cash flow ratio} = \frac{\text{Market price of share}}{\text{Cash flow per share}}$$