Cost Indexes:

Cost at time A	Index value at time A
Cost at time B	Index value at time B

Power sizing:

Cost of asset A	$\left[\frac{\text{Size (capacity) of asset A}}{2} \right]^{x}$
Cost of asset B	$\boxed{\text{Size (capacity) of asset B}}$
x = power - sizing exponent	

Learning Curve:

 $T_N = T_{\text{initial}} \times N^b$ $b = \frac{\log(\text{learning curve rate})}{\log 2}$ $T_N = \text{time to make Nth unit}$ $T_{\text{initial}} = \text{time to make first unit}$

- N = number of finished units
- b = learning curve exponent

Simple Interest:

Interest earned on amount P: I = PinMaturity value : F = P(1+in)i = interest rate per time period n = number of time periods

Compound Interest:

 $F = P(1+i)^{n}$ F = future value P = present value i = periodic interest raten = number of periods

Ordinary Simple Annuity:

$$P = A \left\lfloor \frac{1 - (1+i)^{-n}}{i} \right\rfloor$$
$$F = A \left\lfloor \frac{(1+i)^n - 1}{i} \right\rfloor$$

A = periodic payment (end of period) P, F, i, n as above for compound interest

Ordinary Arithmetic Gradient Annuity:

$$A_{eq} = G \left[\frac{1}{i} - \frac{n}{(1+i)^n - 1} \right]$$
$$P = G \left[\frac{(1+i)^n - in - 1}{i^2 (1+i)^n} \right]$$

 A_{eq} = equivalent periodic payment G = gradient amount (periodic increment) P, i, n as above for compound interest Ordinary Geometric Gradient Annuity:

$$P = A_{1} \left[\frac{1 - (1 + g)^{n} (1 + i)^{-n}}{i - g} \right]; i \neq g$$

$$P = \frac{nA_{1}}{(1 + i)}; i = g$$

$$F = A_{1} \left[\frac{(1 + i)^{n} - (1 + g)^{n}}{i - g} \right]; i \neq g$$

$$F = nA_{1} (1 + i)^{n-1}; i = g$$

$$A = \text{recurrent in first partial (and)}$$

 A_1 = payment in first period (end) g = periodic rate of growth

P, F, i, n as above for compound interest

Simple Annuity Due:

$$P = A \left[\frac{1 - (1+i)^{-n}}{i} \right] (1+i)$$
$$F = A \left[\frac{(1+i)^n - 1}{i} \right] (1+i)$$

A = cash amount (beginning of period)

P, F, i, n as above for compound interest

Nominal, Periodic, Effective Interest Rates:

$$i = \frac{r}{m}$$

 $(1+i_{\rm eff}) = \left(1+\frac{r}{m}\right)^m$

r = nominal interest rate per year m = number of compounding periods per year

 i_{eff} = effective interest rate (compounded annually)

i = periodic interest rate

Equivalent Interest Rates:

 $(1+i_p)^p = (1+i_c)^c$

 i_p = interest rate for payment period

- p = number of payment periods per year
- i_c = interest rate for compounding period
- c = number of compounding periods per year

Ordinary General Annuity:

$$P = A \left[\frac{1 - (1 + i_p)^{-n}}{i_p} \right]$$
$$F = A \left[\frac{(1 + i_p)^n - 1}{i_p} \right]$$

 i_p = interest rate for payment period

n = number of payment periods

P, F, A as above for annuities

Perpetual Annuities:

Ordinary :
$$P = \frac{A}{i}$$

Due : $P = \frac{A}{i}(1+i) = \frac{A}{i} + A$
Geometric Growth : $P = \frac{A}{i-g}$; $i > g$
 P, A, i, g as above for annuities
Investment Criteria:
NPV = $CF_0 + \frac{CF_1}{(1+r)^1} + \frac{CF_2}{(1+r)^2} + \dots + \frac{CF_n}{(1+r)^n}$
NPV = net present value
NFV = $CF_0(1+r)^n + CF_1(1+r)^{n-1} + \dots + CF_n$
NFV = net future value
EACF = equivalent annual cash flow = $\frac{\text{NPV}}{\left[\frac{1-(1+r)^{-n}}{r}\right]}$
 CF_j = cash flow at time j
 n = lifetime of investment
 r = MARR = minimum acceptable rate of return
 $0 = CF_0 + \frac{CF_1}{(1+i)^1} + \frac{CF_2}{(1+i)^2} + \dots + \frac{CF_n}{(1+i)^n}$
 i = IRR = internal rate of return

$$PV(neg CFs, e_{fin}) \times (1+i')^n = FV(pos CFs, e_{inv})$$

i' = MIRR = modified internal rate of return

 $e_{fin} = financing rate of return$

 e_{inv} = reinvestment rate of return

Benefit - cost ratio, BCR = $\frac{PV(\text{positive cash flows})}{PV(\text{negative cash flows})}$

Probability:

(

$$E(X) = Weighted average = \frac{w_1 S_1 + \dots + w_k S_k}{w_1 + \dots + w_k}$$

 w_i = weight for Scenario *i*

 S_i = value of X for Scenario i

$$E(X) = \mu_X$$
 = expected value of $X = \sum_{all j} P(x_j) x_j$

$$Var(X) = variance of X = \sum_{all j} P(x_j)(x_j - \mu_X)^2$$
$$P(x_j) = Probability(X = x_j)$$

Depreciation:

B= initial (purchase) value or cost basis S= estimated salvage value after depreciable life d_t = depreciation charge in year t N= number of years in depreciable life

Book value at end of period t:
$$BV_t = B - \sum_{i=1}^{t} d_i$$

Straight-Line (SL):

Annual charge: $d_t = (B - S)/N$ Book value at end of period t: $BV_t = B - t \times d$

Sum-of-Years'-Digits (SOYD): SOYD = N(N+1)/2Annual charge: $d_t = (B - S)(N - t + 1)/SOYD$ Declining balance (DB): D= proportion of start of period BV that is depreciated Annual charge: $d_n = BD(1-D)^{n-1}$ Book value at end of period n: $BV_n = B(1-D)^n$ Capital Cost Allowance (CCA): d = CCA rate UCC_n= Undepreciated capital cost at end of period n Annual charge: $CCA_1 = B(d/2)$ for n = 1; $CCA_n = Bd(1-d/2)(1-d)^{n-2}$ for $n \ge 2$ UCC at end of period n: UCC_n = $B(1-d/2)(1-d)^{n-1}$ PV(CCA tax shields gained) = $\left\lceil \frac{BdT_C}{i+d} \right\rceil \left\lceil \frac{1+i/2}{1+i} \right\rceil$ PV(CCA tax shields lost) = $\left[\frac{SdT_C}{i+d}\right] \frac{1}{(1+i)^N}$ T_C = firm's tax rate; i = discount rate

Investment Project Cash Flows:

Taxable income = OR-OC-CCA-I Net profit = taxable income $\times (1-T)$ Before-tax cash flow (BTCF) = I+CCA+taxable income After-tax cash flow (ATCF) = Net profit + CCA + I= $(Taxable income) \times (1-T) + CCA + I$ = (BTCF - I - CCA)(1 - T) + CCA + I= (OR - OC)(1 - T) + I(T) + CCA(T)Net cash flow from operations = ATCF - I - DIV= (OR - OC)(1-T) + I(T) + CCA(T) - I - DIV= (OR - OC - I)(1-T) + CCA(T) - DIV= Net profit + CCA – DIV OR= operating revenue; OC= operating cost I= interest expense; DIV = dividends; T= tax rate Net cash flow = Net cash flow from operations + New equity issued + New debt issued

+ Proceeds from asset disposal – Repurchase of equity nt of debt (principal) – Purcha of assets

- Repayment of debt (principal) - Purchase of as:

$$\begin{bmatrix} dT_{c} \ 1+i/2 \end{bmatrix}$$

Net capital investment = $B \left[1 - \frac{dT_C}{i+d} \frac{1+i/2}{1+i} \right]$ Net salvage value = $S \left[1 - \frac{dT_C}{i+d} \right] \left[\frac{1}{(1+i)^N} \right]$

Not salvage value =
$$S \left[1 - \frac{dT_C}{i+d} \right] \left[\frac{1}{(1+i)^N} \right]$$

Inflation:

(1+i) = (1+i)(1+f)i = i' + f + (i')(f)*i*= market interest rate; *i* $\stackrel{\prime}{=}$ real interest rate *f*= inflation rate

Weighted Average Cost of Capital (WACC):

WACC =
$$\frac{D}{V} \times (1 - T_C)i_d + \frac{E}{V} \times i_e$$

V = D + ED= market value of debt; E= market value of equity *V*= market value of firm i_d = cost of (rate of return on) debt after-tax cost of debt: $i_{dt} = i_d(1-T)$ $i_e = \text{cost of equity}$