TIE2140 Engineering Economy
Solutions to Tutorial # 10

Question 1.

The projects in decreasing annual returns and their cumulative investment amounts are shown below:

Project	Investment $m	Cumulative Investment $m	Annual Return
A	10	10	15.0%
E	5	15	12.0%
D	30	45	7.5%
C	30	75	6.0%
B	25	100	5.0%
F	12	112	4.0%

Note that as all the projects have equal life and consists of only an initial cash outflow and a single cash inflow at the end of its life, ranking by project's *IRR* is valid.

(*a*) If the company has $50 million available, and the cost of this capital is 5.5%, then projects *A, E* and *D* should be invested in. The remaining $5*m* should continue to be invested in municipal bonds at 5.5% return. *MARR* = 5.5%.

Note that if the company has only $45 m, remaining fund will be zero, and *MARR* will be 7.5%, which is the *MARR* of the last accepted project.

(*b*) If the company has $100 million available, and the cost of this capital is 5.5%, then projects *A*, *E, D and C* should be invested in. The remaining $25 million should continue to be invested in municipal bonds at 5.5% return. *MARR* = 5.5%

Question 2.

Annual payment = 0.14 (1,000) = $140 for 10 years

Final payment received at the end of 10 years = $1,000

Desired yield = 10% per year

Present worth of receipts = 140 [*P*/*A*, 10%,10] + 1,000 [*P*/*F*, 10%, 10] = $ 1,245.78

Maximum price to pay for the bond = **$ 1,245.78**

Question 3.

Total bond issues = \$1,000,000
Selling fee = \$50,000
Annual coupon payment amount = 0.04 (1,000,000) = \$40,000
Annual admin cost = \$70,256
Final payment at EoY 15 = \$1,000,000

The cost of capital to the company is the *IRR* associated with cash flows to the company. That is, we need to solve:

$$1{,}000{,}000 - 50{,}000 - (40{,}000 + 70{,}256)\,[P/A, i, 15\%] - 1{,}000{,}000\,[P/F, i, 15] = 0$$

$$950{,}000 - 110{,}526\,[P/A, i, 15] - 1{,}000{,}000\,[P/F, i, 15] = 0$$

When $i = 10\%$: $950{,}000 - 110{,}256\,(7.606080) - 1{,}000{,}000\,(0.239392) = -128{,}007.95$
When $i = 12\%$: $950{,}000 - 110{,}256\,(6.810864) - 1{,}000{,}000\,(0.182696) = +\ 16{,}365.06$

By linear interpolation between 10% and 12%, $i \approx \underline{11.77\%}$

Using Excel: = RATE (15, 950000, -110526, -1000000, 0, 0.1) = **<u>11.75%</u>**

Similar answer can be obtained by Excel Goal Seek or any equation solver.

Question 4.

Number of bonds issued = 5,000
Maturity period = 10 years
Face value = \$1,000
Coupon rate = 6%
Annual coupon payment = 0.06 (1,000) = \$60

Expected yield = 8%.

(*a*) Price = 0.06 (1,000) [*P*/*A*, 8%, 10] + 1,000 [*P*/*F*, 8%, 10] = \$865.80

(*b*) Amount raised through bond sale = 865.80 × 5,000 = \$4,328,991.86

(*c*) Let x = after-tax cost of capital. Then

$$865.80 - 60\,(1 - 0.17)\,[P/A, x, 10] - 1{,}000\,[P/F, x, 10] = 0.$$

Using Excel: =RATE(10, - 60* (1 - 0.17), 865.80, -1000, 0, 0.1)

x = **<u>6.88%</u>**

Question 5.

(*a*) Let x = before-tax cost of capital. Then

2,800,000 – 196,000 [*P*/*A*, *x*, 10] – 2,800,000 [*P*/*F*, *x*, 10]

x = 196,000 / 2,800,000 = 0.07

Or using Excel: x =RATE(10, -196000, 2800000, -2800000, 0, 0.1) = 0.07

Hence before-tax cost of capital = **7.00%.**

(*b*) The annual interest payments of $196,000 can be charged as expense for income tax purpose.

Annual BTCF for interests = –$ 196,000
Taxable income = –$ 196,000
Annual Income tax Cash flow= (–0.17) (–196,000) = $33,320.00
Annual ATCF for interests = – $196,000 + $33,320.00 = –$162,680.00

Let y = after-tax cost of capital. Then

2,800,000 – 162,680 [*P*/*A*, *y*, 10] – 2,800,000 [*P*/*F*, *y*, 10]

Using Exel: y =RATE(10, –162680, 2800000, –2800000, 0, 0.1) = 0.0581

Hence after-tax cost of capital = **5.81%**