Engineering Economics Homework I

Kathryn Atherton

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Problem 1:

You have been asked to select a purification unit for a process and have narrowed it to the following two alternatives:

Option 1:

- Initial investment = $180,000
- Salvage value = $15,000
- Service live = 6 years
- Annual operating expenses = $25,000

Option 2:

- Initial investment = $210,000
- Salvage value = $20,000
- Service live = 8 years
- Annual operating expenses = $20,000

Assuming an annual interest rate of 20%, and using annualized costs, which alternative is recommended?

```
clear;
P1              = 180000;                       % [$]
F1              = 15000;                        % [$]
N1              = 6;                            % [years]
A1              = 25000;                        % [$]

P2              = 210000;                       % [$]
F2              = 20000;                        % [$]
N2              = 8;                            % [years]
A2              = 20000;                        % [$]

i               = 0.2;                          % [%]

% annualize all costs and compare
% option 1
A_investment1   = present_annual(P1, i, N1);    % [$ / year]
A_future1       = future_annual(F1, i, N1);     % [$ / year]
Annual1         = A_future1 - A_investment1 ...
                    - A1                        % [$ / year]
```

```
Annual1 = -7.7616e+04
```

The annualized cost of option 1 is $77,616 / year.

```
% option 2
A_investment2   = present_annual(P2, i, N2);    % [$ / year]
A_future2       = future_annual(F2, i, N2);     % [$ / year]
Annual2         = A_future2 - A_investment2 ...
                    - A2                        % [$ / year]
```

```
Annual2 = -7.3516e+04
```

The annualized cost of option 2 is $73,516 / year.

Answer: Option 2 costs less than option 1 per year, so option **2 is recommended**.

Problem 2:

From your income, you have enough money to save $10,000/year plus rent a house for $12,000/year including utilities.

You have accumulated $20,000 in your savings account which earns interest at 4%.

You have the option of buying the house for $134,000 and thereby incur the following annual costs:

- Taxes and insurance = $2,000
- Maintenance = $1,600
- Utilities = $2,400
- Interest on loan = 6% (of principle)
- Income tax rate = 25%

To buy the house, you use your savings for a down payment and make the maximum payments possible yearly toward the loan assuming that all your extra money goes into paying the loan or expenses for the house.

Further assume that inflation increases the value of the house by 3% compounded annually and at the end of four years you can sell the house at the increased value.

Determine whether you should buy this house or continue to rent during the next four year period. Interest income is taxable, interest costs are tax deductible.

```
clear;
income_post_tax = 22000;                    % [$/year]
rent            = 12000;                    % [$/year]
savings         = 20000;                    % [$]
savings_i       = 0.04;                     % [%]

taxes           = 2000;                     % [$/year]
maintenance     = 1600;                     % [$/year]
utilities       = 2400;                     % [$/year]
```

```
loan_i          = 0.06;                         % [%]
income_tax      = 0.25;                         % [%]

house           = 134000;                       % [$]
house_i         = 0.03;                         % [%]
N               = 4;                            % [years]

% annualize costs and compare
% renting
income_saved    = income_post_tax - rent;       % [$ / year]
savings_0       = (savings * (savings_i) * ...
                    (1 - income_tax)) + savings;% [$ in savings after year 1]
savings_1       = ((savings_0 + income_saved) ...
                    * (savings_i) * (1 - income_tax)) ...
                    + savings_0 + income_saved; % [$ in savings after year 2]
savings_2       = ((savings_1 + income_saved) * ...
                    (savings_i) * (1 - income_tax)) ...
                    + savings_1 + income_saved; % [$ in savings after year 3]
savings_3       = ((savings_2 + income_saved) * ...
                    (savings_i) * (1 - income_tax))...
                    + savings_2 + income_saved; % [$ in savings after year 4]
future_renting  = savings_3 + income_saved      % [$ after year 4]
```

```
future_renting = 6.4346e+04
```

```
% buying
% value of house
house_f         = single_future(house, house_i, N);

% costs of house
initial_payment = savings;
owed_0          = house - savings;              % [$ owed at year 0]
loan            = single_future(owed_0, loan_i * (1 - income_tax), N);
                                                % [$ owed total]
payment         = income_post_tax - taxes - ...
                    maintenance - utilities;    % [$ paid on loan per year]
payment_f       = annual_future(payment, loan_i * (1 - income_tax), N);
                                                % [$ paid total]
future_house    = house_f + payment_f - loan    % [$ at end of year 4]
```

```
future_house = 8.3322e+04
```

Answer: As the value recouped from the house after four years is greater than the value of the savings account at the end of four years, **you should buy the house**.

Problem 3:

A company is currently buying milk solids from a vendor at an annual cost of $30,000. A drying plant can be purchased from APV for an installed cost of $100,000. The plant has a life expectancy of ten years and negligible salvage value. The building site is valued at $10,000 and does not depreciate. Assuming interest is 16% compounded annually, what are the annual

maintenance and operating charges that can be paid to make the purchase of the drying plant a break-even proposition?

```
clear;
cost            = 30000;                          % [$ / year]
installation    = 100000;                         % [$]
N               = 10;                             % [years]
land_p          = 10000;                          % [$]
land_f          = 10000;                          % [$]
i               = 0.16;                           % [%]

% annualize costs and compare
a_installation  = present_annual(installation, i, N);
                                                  % [$ / year]
a_land_p        = present_annual(land_p, i, N); % [$ / year]
a_land_f        = future_annual(land_f, i, N);  % [$ / year]
maintenance     = cost - a_installation - ...
                    a_land_p + a_land_f           % [$ / year]
```

```
maintenance = 7.7099e+03
```

Answer: To make the purchase a break-even proposition, the maintenance and operating charges must be **$7,709.90 / year**.

Problem 4:

A company is considering the purchase of a plant for $350,000 which would have service life of ten years and which would yield annual sales of $500,000. The annual operating expenses are $300,000. The value of land, equipment, buildings, etc. at the end of 10 years is estimated to be $100,000. The company uses straight line depreciation. The tax rate is 47% and required working capital is $50,000. The company requires a 25% after tax rate of return (i = 25%). Is this an acceptable investment?

```
clear;
p               = 350000;                         % [$]
sales           = 500000;                         % [$ / year]
expenses        = 300000;                         % [$ / year]
f               = 100000;                         % [$]
N               = 10;                             % [years]
tax             = 0.47;                           % [%]
capital         = 50000;                          % [$ / year]
i               = 0.25;                           % [%]

% annualize costs and compare
depreciation    = (p - f) / N;                    % [$ / year]
gross_profit    = sales - expenses;               % [$ / year]
profit          = gross_profit - depreciation;  % [$ / year]
net_profit      = profit * (1 - tax);             % [$ / year]
TCI             = p + capital;                    % [$]
annual_p        = present_annual(p, i, N);      % [$ / year]
```

```
annual_f        = future_annual(f, i, N);       % [$ / year]
net             = net_profit - annual_p + ...
                      annual_f                  % [$ / year]
```

```
net = -2.2681e+03
```

Answer: As the net value of this investment is less than $0 every year, **this is not an acceptable investment.**

Functions

```
function F = single_future(P, i, N)
    % single payment compound amount
    F = P * (1 + i) ^ N;
end

function P = single_present(F, i, N)
    % single payment present worth
    P = F / (1 + i) ^ N;
end

function F = annual_future(A, i, N)
    % uniform series compound amount
    F = A * ((1 + i) ^ N - 1) / i;
end

function P = annual_present(A, i, N)
    % uniform series present worth
    P = A * ((1 + i) ^ N - 1) / (i * (1 + i) ^ N);
end

function A = future_annual(F, i, N)
    % sinking fund
    A = F * i / ((1 + i) ^ N - 1);
end

function A = present_annual(P, i, N)
    % capital recovery
    A = P * (i * (1 + i) ^ N) / (((1 + i) ^ N) - 1);
end
```