Engineering Economics Homework II

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Problem 7-2:

The original cost for a distillation tower is $50,000, and the useful life of the tower is estimated to be 10 years. How much must be placed annually in an annuity at an interest rate of 6 percent to obtain sufficient funds to replace the tower at the end of 10 years? If the scrap value of the distillation tower is $5000, determine the asset value (i.e., the total book value of the tower) at the end of 5 years based on straight line depreciation.

```
clear;
investment = 50000; % [$]
n = 10; % [years]
i = 0.06; % [%]
salvage_10 = 5000; % [$]
n_mid = 5; % [years]

present = single_present(investment, i, n);
annual = present_annual(present, i, n)
```

```
annual = 3.7934e+03
```

Answer: The annual annuity is **$3,793.**

```
value = investment - salvage_10;
depreciation = value / n;
asset_value = investment - depreciation * n_mid
```

```
asset_value = 27500
```

Answer: The asset value is **$27,500**

Problem 7-5:

Use annualized cost

A heat exchanger is to be used in a heating process. A standard type of heat exchanger with a negligible scrap value costs $20,000 and will have a useful life of 6 years. Another type of heat exchanger with equivalent design capacity is priced at $34,000 but with a useful life of 10 years and a scrap value of $4000. Assume an effective compound interest rate of 6 percent per year and that the replacement cost of each exchanger is the same as that of the original exchanger. Determine which heat exchanger is cheaper by comparing the capitalized cost of each. See Prob. 7-4 for a definition of capitalized cost.

```
clear;
```

```
investment_1    = 20000;                           % [$]
n_1             = 6;                               % [years]
scrap_1         = 0;                               % [$]
investment_2    = 34000;                           % [$]
n_2             = 10;                              % [years]
scrap_2         = 4000;                            % [$]
i               = 0.06;                            % [% per year]

A_investment_1  = present_annual(investment_1, i, n_1); % [% / year]
A_investment_2  = present_annual(investment_2, i, n_2); % [$ / year]
A_scrap_2       = future_annual(scrap_2, i, n_2);       % [$ / year]

A_1             = A_investment_1                   % [% / year]
```

```
A_1 = 4.0673e+03
```

```
A_2             = A_investment_2 - A_scrap_2       % [$ / year]
```

```
A_2 = 4.3160e+03
```

Answer: The first heat exchanger costs $4,067.30 / year and the second costs $4,316 / year, so **the first heat exchanger is cheaper**.

Problem 7-9:

The fixed-capital investment for an existing chemical plant is $20 million. Annual property taxes amount to 1 percent of the fixed-capital investment, and state income taxes are 5 percent of the gross earnings. The net income after all taxes is $2 million, and the federal income taxes amount to 35 percent of gross earnings. If the same plant had been constructed for the same fixed-capital investment but at a location where property taxes were 4 percent of the fixed-capital investment and state income taxes were 2 percent of the gross earnings, what would be the net income per year after taxes, assuming all other cost factors were unchanged?

```
clear;
investment = 20000000; % [$]
tax_property_1 = 0.01 * investment; % [$ / year]
tax_state_1 = 0.05; % [%]
income_after_tax_1 = 2000000; % [%]
tax_federal = 0.35; % [%]
tax_property_2 = 0.04 * investment; % [$ / year]
tax_state_2 = 0.02; % [%]

gross_income = (income_after_tax_1 - tax_property_1) / (tax_state_1 + tax_federal)
```

```
gross_income = 4500000
```

```
income_after_tax_2 = tax_property_2 + tax_state_2 * gross_income + tax_federal * gross_income
```

```
income_after_tax_2 = 2465000
```

Answer: The net income per year in the new location is **$2,465,000**.

Problem 7-11:

The initial installed cost for a new piece of equipment is $10,000. After the equipment has been in use for 4 years, it is sold for $7000. The company that originally owned the equipment employs a straight-line method for determining depreciation costs. If the company had used the MACRS 5-year method for determining depreciation costs, the asset or book value for the piece of equipment at the end of 4 years would have been $1728. The total income tax rate for the company is 35 percent of all gross earnings. Capital gains taxes amount to 20 percent of the gain. How much net savings would the company have achieved by using the MACRS method instead of the straight-line depreciation method?

```
clear;
investment = 10000; % [$]
n = 4; % [years]
salvage_straight = 7000; % [$]
salvage_MACRS = 1728; % [$]
income_tax = 0.35; % [%]
gains_tax = 0.2; % [%]

depreciation_1 = investment / 5; % [$]
value_1 = investment - depreciation_1; % [$]
depreciation_2 = value_1 / 4.5; % [$]
value_2 = value_1 - depreciation_2; % [$]
depreciation_3 = value_2 / 3.5; % [$]
value_3 = value_2 - depreciation_3; % [$]
depreciation_4 = value_3 / 2.5; % [$]
value_4 = value_3 - depreciation_4; % [$]

tax_saved_straight = income_tax * (depreciation_1 + depreciation_2 + depreciation_3 + deprecia
capital_gain_tax_straight = gains_tax * (salvage_straight - value_4);
savings_straight = tax_saved_straight - capital_gain_tax_straight
```

```
savings_straight = 1700
```

```
depreciation_1_macrs = investment * 2 * (1 / 5) / 2; % [$]
value_1_macrs = investment - depreciation_1_macrs; % [$]
depreciation_2_macrs = investment * 2 * (0.8 / 5); % [$]
value_2_macrs = value_1_macrs - depreciation_2_macrs; % [$]
depreciation_3_macrs = investment * 2 * (0.48 / 5); % [$]
value_3_macrs = value_2_macrs - depreciation_3_macrs; % [$]
depreciation_4_macrs = investment * 2 * (0.288 / 5); % [$]
value_4_macrs = value_3_macrs - depreciation_4_macrs; % [$]

tax_saved_macrs = income_tax * (depreciation_1_macrs + depreciation_2_macrs + depreciation_3_ma
capital_gain_tax_macrs = gains_tax * (salvage_straight - salvage_MACRS);
savings_macrs = tax_saved_macrs - capital_gain_tax_macrs;

savings_macrs_straight = savings_macrs - savings_straight
```

```
savings_macrs_straight = 140.8000
```

Answer: The company saves **$140.80** with MACRS over straight-line depreciation.

Problem 7-14:

A chemical company has a total income of $1 million per year and total expenses of $600,000 not including depreciation. At the start of the first year of operation, a composite account of all depreciable assets shows a value of $850,000 with a MACRS recovery period of 5 years, and a straight-line recovery period of 9.5 years. Thirty-five percent of all profits before taxes must be paid out for income taxes. What would be the reduction in income tax charges for the first year of operation if the MACRS method were used for the depreciation accounting instead of the straight-line method?

```
clear;
income = 1000000; % [$ / year]
expenses = 600000; % [$ / year]
value_0 = 850000; % [$]
n_MACRS = 5; % [years]
n_straight = 9.5; % [years]
tax = 0.35; % [%]

income_tax_without_depreciation = (income - expenses) * tax; % [$ / year]

straight_depreciation = value_0 / n_straight; % [$ / year]
tax_reduction_straight = tax * straight_depreciation; % [$ / year]

macrs_depreciation = value_0 * 0.2; % [$ / year]
tax_reduction_macrs = tax * macrs_depreciation; % [$ / year]
additional_reduction_macrs = tax_reduction_macrs - tax_reduction_straight % [$ / year]
```

```
additional_reduction_macrs = 2.8184e+04
```

Answer: The additional tax reduction if MACRS depreciation is used instead of straight line is **$28,184 / year**.

Problem 7-17:

A laboratory piece of equipment was purchased for $35,000 and is estimated to be used for 5 years with a salvage value of $5000. Tabulate the annual depreciation allowances and year-end book values for the 5 years by using (1) the straight-line depreciation method, (2) the MACRS 5-yr recovery period depreciation method, and (3) the sum-of-the-digits depreciation method.

```
clear;
investment = 35000; % [$]
n = 5; % [years]
salvage = 5000; % [$]

depreciation_straight = (investment - salvage) / n;
value_straight_1 = investment - (investment - salvage) / n
```

```
value_straight_1 = 29000
```

```
value_straight_2 = value_straight_1 - (investment - salvage) / n
```

```
value_straight_2 = 23000
```

```
value_straight_3 = value_straight_2 - (investment - salvage) / n
```

```
value_straight_3 = 17000
```

```
value_straight_4 = value_straight_3 - (investment - salvage) / n
```

```
value_straight_4 = 11000
```

```
value_straight_5 = value_straight_4 - (investment - salvage) / n
```

```
value_straight_5 = 5000
```

```
dep_macrs = [0.2, 0.32, 0.192, 0.1152, 0.1152, 0.0576];
annual_dep_macrs = investment .* dep_macrs
```

```
annual_dep_macrs = 1×6
        7000       11200        6720        4032        4032        2016
```

```
value_macrs_1 = investment - annual_dep_macrs(1)
```

```
value_macrs_1 = 28000
```

```
value_macrs_2 = value_macrs_1 - annual_dep_macrs(2)
```

```
value_macrs_2 = 16800
```

```
value_macrs_3 = value_macrs_2 - annual_dep_macrs(3)
```

```
value_macrs_3 = 10080
```

```
value_macrs_4 = value_macrs_3 - annual_dep_macrs(4)
```

```
value_macrs_4 = 6048
```

```
value_macrs_5 = value_macrs_4 - annual_dep_macrs(5)
```

```
value_macrs_5 = 2016
```

```
value_macrs_6 = value_macrs_5 - annual_dep_macrs(6)
```

```
value_macrs_6 = 0
```

```
sod = n * (n + 1) / 2;
value_sod_1 = investment - (5 / sod) * (investment - salvage)
```

```
value_sod_1 = 25000
```

```
value_sod_2 = value_sod_1 - (4 / sod) * (investment - salvage)
```

```
value_sod_2 = 17000
```

```
value_sod_3 = value_sod_2 - (3 / sod) * (investment - salvage)
```

```
value_sod_3 = 11000
```

```
value_sod_4 = value_sod_3 - (2 / sod) * (investment - salvage)
```

```
value_sod_4 = 7000
```

```
value_sod_5 = value_sod_4 - (1 / sod) * (investment - salvage)
```

```
value_sod_5 = 5000
```

Problem 8-4:

Use annualized cost.

Two pumps are being considered for pumping water from a reservoir. Installed cost and salvage value for the two pumps are given below:

```
clear;
installed_a = 20000; % [$]
installed_b = 25000; % [$]
salvage_a = 2000; % [$]
salvage_b = 4000; % [$]
```

Pump A has a service life of 4 years. Determine the service life of pump B at which the two pumps are competitive if the annual effective interest rate is 15 percent. Competitiveness refers to the requirement that the installed cost of the pumps plus the amount that must be invested at the lime of installation so that sufficient interest will be earned over the service life (when added to the salvage value) to replace the pumps at the original cost.

```
n_a = 4; % [years]
i = 0.15; % [%]

annual_installed_a = present_annual(installed_a, i, n_a);
annual_salvage_a = future_annual(salvage_a, i, n_a);
annual_a = annual_installed_a - annual_salvage_a;

annual_b = 0;
n_b = n_a;
while (annual_b > annual_a + 1) || (annual_b < annual_a - 1)
    annual_installed_b = present_annual(installed_b, i, n_b);
    annual_salvage_b = future_annual(salvage_b, i, n_b);
    annual_b = annual_installed_b - annual_salvage_b;
    n_b = n_b + 0.01;
```

```
end
n_b
```

```
n_b = 5.3300
```

Answer: When the annualized costs of pumps A and B is equal, the lifespan of pump B is found to be 5.33 years.

Problem 8-5:

A heat exchanger has been designed, and insulation is being considered for the unit. The insulation can be obtained in thicknesses of 0.025,0.051. 0.076, or 0.102 m. The following data have been determined for the different insulation thicknesses:

```
clear;
thickness = [0.025, 0.051, 0.076, 1.02]; % [m]
energy_save = [88, 102, 108, 111]; % KJ/s
cost_install = [8000, 10100, 11100, 11500]; % [$]
annual_fixed_perc = 0.10; % [%]
```

What thickness of insulation should be used? The value of heat is $1.50/GJ. An annual after-tax return of 15 percent on the fixed-capital investment is required for any capital utilized in this type of investment. The income tax rate is 35 percent/yr. The exchanger operates for 300 days/yr.

```
heat_price = 1.5; % [$/GJ]
i = 0.15; % [%]
tax = 0.35; % [%]
days = 300; % [operating days / year]

annual_fixed_charges = annual_fixed_perc .* cost_install;
heat_savings = energy_save .* (3600 * 24 * days) / 1000000;
heat_savings_cost = heat_savings * heat_price;
income_tax = tax * heat_savings_cost;
net_income = heat_savings_cost - income_tax - annual_fixed_charges;
annual_return = i * cost_install;

profit = net_income - annual_return
```

```
profit = 1×4
  223.9360   52.7440  -45.6240  -69.8080
```

Answer: The increase in profit per year is $223.94, $52.74, -$45.62, and -$69.81 for insulation sizes of 0.025, 0.051, 0.076, and 1.02 m, respectively. **The insulation size of 0.025 m should be used** because profit is maximized with this size.

Problem 8-7:

A company must purchase one reactor to be used in an overall operation. Four reactors have been designed, all of which are equally capable of giving the required service. The following data apply to the four designs:

```
clear;
fci_1 = 10000; % [$]
fci_2 = 12000; % [$]
fci_3 = 14000; % [$]
fci_4 = 16000; % [$]

afc_1 = 3000; % [$]
afc_2 = 2800; % [$]
afc_3 = 2350; % [$]
afc_4 = 2100; % [$]
```

If the company demands a 15 percent return after taxes on any unnecessary investment, which of the four designs should be accepted?

```
i = 0.15;
compare_1_2 = (afc_1 - afc_2) / (fci_2 - fci_1)
```

```
compare_1_2 = 0.1000
```

```
compare_1_3 = (afc_1 - afc_3) / (fci_3 - fci_1)
```

```
compare_1_3 = 0.1625
```

```
compare_1_4 = (afc_1 - afc_4) / (fci_4 - fci_1)
```

```
compare_1_4 = 0.1500
```

```

compare_3_4 = (afc_3 - afc_4) / (fci_4 - fci_3)
```

```
compare_3_4 = 0.1250
```

Answer: Design **3** is the best because it ha a return greater than 15% over design 1 and design 4 does not have a return greater than 15% over design 3.

Problem 8-10:

Tax = 35%.

A proposed chemical plant has the following projected revenues and operating expenses in millions of dollars

```
clear;
ar_1 = 7.0; % [$1,000,000]
ar_2 = 10.0; % [$1,000,000]
ar_3 = 15.0; % [$1,000,000]
ar_4 = 20.0; % [$1,000,000]
ar_5 = 22.5; % [$1,000,000]
```

```
ar_6 = 24.0; % [$1,000,000]
ar_7 = 25.0; % [$1,000,000]

aoe_1 = 4.0; % [$1,000,000]
aoe_2 = 5.6; % [$1,000,000]
aoe_3 = 6.8; % [$1,000,000]
aoe_4 = 7.8; % [$1,000,000]
aoe_5 = 8.8; % [$1,000,000]
aoe_6 = 9.6; % [$1,000,000]
aoe_7 = 10.0; % [$1,000,000]
```

The fixed-capital investment for the plant is $50 million with a working capital of $7.5 million. Using a MACRS depreciation schedule with a class life of 5 years, determine

```
tax = 0.35; % [%]
investment = 50000000; % [$]
working_capital = 7500000; % [$]
n = 5; % [years]
```

a. The annual cash flows

```
depreciation_1 = 0.2; % [%]
depreciation_2 = 0.32; % [%]
depreciation_3 = 0.192; % [%]
depreciation_4 = 0.1152; % [%]
depreciation_5 = 0.1152; % [%]
depreciation_6 = 0.0576; % [%]

cash_flow_1 = (ar_1 - aoe_1) * 1000000  + depreciation_1 * investment
```

```
cash_flow_1 = 13000000
```

```
cash_flow_2 = (ar_2 - aoe_2) * 1000000  + depreciation_2 * investment
```

```
cash_flow_2 = 20400000
```

```
cash_flow_3 = (ar_3 - aoe_3) * 1000000  + depreciation_3 * investment
```

```
cash_flow_3 = 17800000
```

```
cash_flow_4 = (ar_4 - aoe_4) * 1000000  + depreciation_4 * investment
```

```
cash_flow_4 = 17960000
```

```
cash_flow_5 = (ar_5 - aoe_5) * 1000000  + depreciation_5 * investment
```

```
cash_flow_5 = 19460000
```

```
cash_flow_6 = (ar_6 - aoe_6) * 1000000  + depreciation_6 * investment
```

```
cash_flow_6 = 17280000
```

```
cash_flow_7 = (ar_7 - aoe_7) * 1000000
```

```
cash_flow_7 = 15000000
```

Answer: The cash flows for years 1 - 7 are **$13,000,000**, **$20,400,000**, **$17,800,000**, **$17,960,000**, **$19,460,000**, **$17,280,000**, and **$15,000,000**, respectively.

b. The net present worth, using a nominal discount rate of 15 percent

```
i = 0.15; % [%]
n = 7;
PV_0 = -1 * (investment + working_capital); % [$]
PV_1 = cash_flow_1 / (1 + i) ^ 1 % [$]
```

```
PV_1 = 1.1304e+07
```

```
PV_2 = cash_flow_2 / (1 + i) ^ 2 % [$]
```

```
PV_2 = 1.5425e+07
```

```
PV_3 = cash_flow_3 / (1 + i) ^ 3 % [$]
```

```
PV_3 = 1.1704e+07
```

```
PV_4 = cash_flow_4 / (1 + i) ^ 4 % [$]
```

```
PV_4 = 1.0269e+07
```

```
PV_5 = cash_flow_5 / (1 + i) ^ 5 % [$]
```

```
PV_5 = 9.6751e+06
```

```
PV_6 = cash_flow_6 / (1 + i) ^ 6 % [$]
```

```
PV_6 = 7.4706e+06
```

```
PV_7 = (cash_flow_7 + 7500000) / (1 + i) ^ 7 % [$]
```

```
PV_7 = 8.4586e+06
```

```
NPV = PV_0 + PV_1 + PV_2 + PV_3 + PV_4 + PV_5 + PV_6 + PV_7
```

```
NPV = 1.6806e+07
```

Answer: The net present worth is **$16,806,000**.

c. The DCFR

```
DC = (PV_1 / (1 + i) ^ n) + (PV_2 / (1 + i) ^ n) + (PV_3 / (1 + i) ^ n) + (PV_4 / (1 + i) ^ n)
```

```
DC = 2.7935e+07
```

Answer: The discount cash flow is **$27,935,000**.

Problem 8-11:

A power plant for generating electricity is part of a plant design proposal. Two alternative power plants with the necessary capacity have been suggested. One uses a boiler and steam turbine while the other uses a gas turbine. The following information applies to the two proposals:

```
investment_bst = 600000; % [$]
fuel_bst = 160000; % [$/year]
maintenance_bst = 12000; % [$/year]
insurance_bst = 18000; % [$/year]
n_bst = 20; % [years]
salvage_bst = 0; % [$]

investment_gas = 400000; %[$]
fuel_gas = 230000; % [$/year]
maintenance_gas = 15000; % [$/year]
insurance_gas = 12000; % [$/year]
salvage_gas = 0; % [$]
n_gas = 10; % [years]
i = 0.12; % [%]
```

```
gas_new = investment_gas + (investment_gas / (i + 1) ^ n_gas)
```

```
gas_new = 5.2879e+05
```

```
bs_deprec = (investment_bst - salvage_bst)  / n_bst;
bs_expense = bs_deprec + fuel_bst + maintenance_bst + insurance_bst
```

```
bs_expense = 220000
```

```
gas_deprec = (gas_new - salvage_gas) / n_gas;
gas_expense = gas_deprec + fuel_gas + maintenance_gas + insurance_gas
```

```
gas_expense = 3.0988e+05
```

Answer: The boiler and steam turbine costs $220,000. The gas turbine costs $309,880. **The boier and steam turbine is cheaper**.

Problem 8-13:

A chemical company is considering replacing a batch reactor with a continuous reactor. The old unit cost $40,000 when new 5 years ago, and depreciation has been charged on a straight-line basis using an estimated service life of 10 years with a final salvage value of $1000. The new unit would cost $70,000. It would save $15,000 per year in expenses not including depreciation. The straight-line depreciation period is taken to be 10 years with a zero salvage value. All costs other than those for labor, insurance, taxes, and depreciation may be assumed to be the same for both units. The old unit can now be sold for $5000. Income tax is 35 percent per year. If the after-tax minimum acceptable return on any investment is 15 percent. Should the replacement be made?

```
investment_1 = 40000; % [$]
n_1 = 5; % [years of service - years since bought]
salvage_1 = 1000; % [$]
investment_2 = 70000; % [$]
savings_2 = 15000; % [$ / year]
n_2 = 10; % [years]
salvage_2 = 0; % [$]
sell_1 = 5000; % [$]
tax = 0.35; % [%]
i = 0.15; % [%]

annual_1 = present_annual(investment_1, i, n_1);
depreciation_1 = investment_1 / n_1 * tax;
salvage_1 = future_annual(salvage_1, i, n_1);

annual_2 = present_annual((investment_2 - sell_1), i, n_2);
depreciation_2 = (investment_2 - sell_1) / n_2 * tax;
savings = savings_2 * (1 - tax);

total_1 = annual_1 - depreciation_1 - salvage_1
```

```
total_1 = 8.9843e+03
```

```
total_2 = annual_2 - depreciation_1 + savings
```

```
total_2 = 1.9901e+04
```

Answer: The old reactor costs $8,984.30/year and the new reactor costs $19,901.00/year so **the old reactor is a better value**.

Problem 8-16:

An engineer in charge of the design of a plant must choose either a batch or a continuous system. The batch system offers a lower initial outlay but, because of higher labor requirements, exhibits a higher operating cost. The cash flows relevant to this decision have been estimated as follows:

```
batch_year0 = -20000; % [$]
batch_year10 = 5600; % [$/year]
batch_i = 0.25; % [%]
batch_net_worth = 14400; % [%]

continuous_year0 = -30000; % [$]
continuous_year10 = 7650; % [$/year]
continuous_i = 0.22; % [%]
continuous_net_worth = 17000; % [%]
```

Check the values given for the discounted cash flow rate of return and net present worth. If the company requires a minimum rate of return of 10 percent, which system should be chosen?

```
i = 0.10;
n = 10;
NPV_batch = batch_year0;
years = 1;
while years <= n
    NPV_batch = NPV_batch + (batch_year10 / ((1 + i) ^ years));
    years = years + 1;
end
NPV_batch
```

```
NPV_batch = 1.4410e+04
```

```
years = 1;
NPV_continuous = continuous_year0;
while years <= n
    NPV_continuous = NPV_continuous + (continuous_year10 / ((1 + i) ^ years));
    years = years + 1;
end
NPV_continuous
```

```
NPV_continuous = 1.7006e+04
```

```
NPV_batch = batch_year0;
years = 1;
while years <= n
    NPV_batch = NPV_batch + (batch_year10 / ((1 + batch_i) ^ years));
    years = years + 1;
end
NPV_batch
```

```
NPV_batch = -5.1817
```

```
years = 1;
NPV_continuous = continuous_year0;
while years <= n
    NPV_continuous = NPV_continuous + (continuous_year10 / ((1 + batch_i) ^ years));
    years = years + 1;
end
NPV_continuous
```

```
NPV_continuous = -2.6856e+03
```

Answer: The NPV values given are correct but the IRR values are not because the NPV values when calculated with the IRR values are not zero. **The continuous system should be chosen** because it has a higher NPV.

Problem 8-17:

An oil company is offered a lease of a group of oil wells on which the primary reserves are close to exhaustion. The major condition of the purchase is that the oil company agree to undertake a water flood project at the end of 5 years to undertake possible secondary recovery. No immediate payment by the oil company is required. The relevant cash flows have been estimated as follows:

```
year_0 = 0; % [$]
year_1_4 = 50000; % [$/year]
year_5 = -650000; % [$]
year_6_20 = 100000; % [$/year]
net_worth = 242000; % [$]
```

Continuous, constant cash flows were used except for the expenditure that occurs in one sum at the end of year 5. Continuous discounting at 10 percent per year was used for all cash flows. Check the net present worth value. Should the lease and flood arrangement be accepted? How should this proposal be presented to the company board of directors who understand and make it a policy to evaluate proposals by using the discounted cash flow rate of return method?

```
n = 5; % [years]
i = 0.10; % [%]

P0_1_4 = year_1_4 * ((1 + i) ^ 4 - 1) / (i * (i + 1) ^ 4); % [$]
P0_5 = year_5 / ((1 + i) ^ 5); % [$]
P0_6_20 = year_6_20 * ((1 + i) ^ 15 - 1)/ (i * (1 + i) ^ 15); % [$]
P0_6_20 = P0_6_20 / (1 + i) ^ 15;
```

NPW = (P0_1_4 - P0_5 + P0_6_20) * (1 - (1 - 0.04461)) * (1 - IRR) + (P0_1_4 - P0_5 + P0_6_20) * (1 - 0.04461)

For 10%, NPW = $226,158.70

NPW = 0 for discounted cash flow rate of return

Answer: For current present net worth, the deal **should not be accepted** because it's worth less than the current NPW.

Problem 8-18:

A process with a depreciable capital investment of $100 million is to be constructed over a 3-year period. At start-up, $20 million of working capital is required. The plant is expected to operate for 10 years. At full capacity expected for the third and subsequent years of operation, the sales revenues are projected to be $150 million per year, and the total operating expenses, excluding depreciation, are projected to be $100 million per year. During the first and second years of operation, the sales revenues are anticipated to be 50 and 75 percent of the sales revenues projected in the third and subsequent years, respectively. The operating expenses during the first and second years will be the same as in the third and subsequent years. Assume that the income tax rate is 35 percent. Using the third year as a basis, determine:

```
investment = 100000000; % [$]
n_construction = 3; % [years]
```

```
working_capital = 20000000; % [$]
n = 10; % [years]
revenue = 150000000; % [$ / year], years 3+
operations = 100000000; % [$ / year]
revenue_1 = 0.5 * revenue; % [$ / year], year 1
revenue_2 = 0.75 * revenue; % [$ / year], year 2
tax = 0.35; % [%]
```

a. The return on the investment after taxes

```
sales_revenue_0 = revenue_1 + revenue_2; % [$]
operating_0 = -1 * operations * 2; % [$]
tax_0 = (tax * (revenue_1 - operations)) + (tax * (revenue_2 - operations)); % [$]
cash_flow_0 = -1 * investment - working_capital + sales_revenue_0 + operations - tax; % [$]
cash_flow_3_9 = (revenue - operations) * tax * -1 + revenue - operations;
cash_flow_10 = working_capital - (revenue - operations) * tax + revenue - operations;
```

$$\frac{\text{cashflow1}}{(1+r)^7}+\frac{\text{cashflow2}}{(1+r)^6}+\frac{\text{cashflow3}}{(1+r)^5}+\frac{\text{cashflow4}}{(1+r)^4}+\frac{\text{cashflow5}}{(1+r)^3}+\frac{\text{cashflow6}}{(1+r)^2}+\frac{\text{cashflow7}}{(1+r)^1}=\text{investment}$$

Answer: Solving for r, the IRR was found to be **26%**.

b. The payback period

```
payback = 5 + (cash_flow_3_9) / (cash_flow_0 + 3 * cash_flow_3_9)
```

```
payback = 5.1226
```

Answer: The payback period is **5.12 years**.

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
```