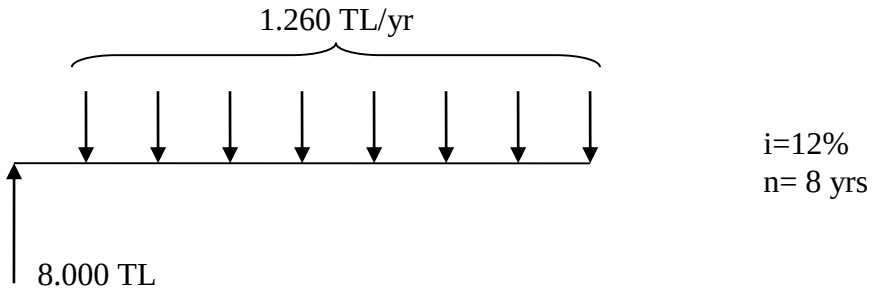
CE 231
ENGINEERING ECONOMY

PROBLEM SET 3

PROBLEM 1

A temporary warehouse with zero salvage value can be bought for 8.000 TL. The annual rental income is estimated to be 1.260 TL. If the interest rate is 12 % and the warehouse is used 8 years will this be a desirable investment? If not, in order to be desirable investment, how many years should the warehouse be rented? Use present worth approach.



PW (12) = - 8.000 + 1.260 (P/A,12%,8)

= - 8.000 + 1.260 * 4,968

PW (12) = - 1.740,32 THIS IS NOT DESIRABLE!

PW (12) = 0 = - 8.000 + 1.260 (P/A,12%,n)

(P/A,12%,n) = 8.000/1.260 = 6,3492

n= 12 f_1 = 6,194

n= 13 f_2 = 6,424

$$n = 12 + \frac{6,3492 - 6,194}{6,424 - 6,194}$$

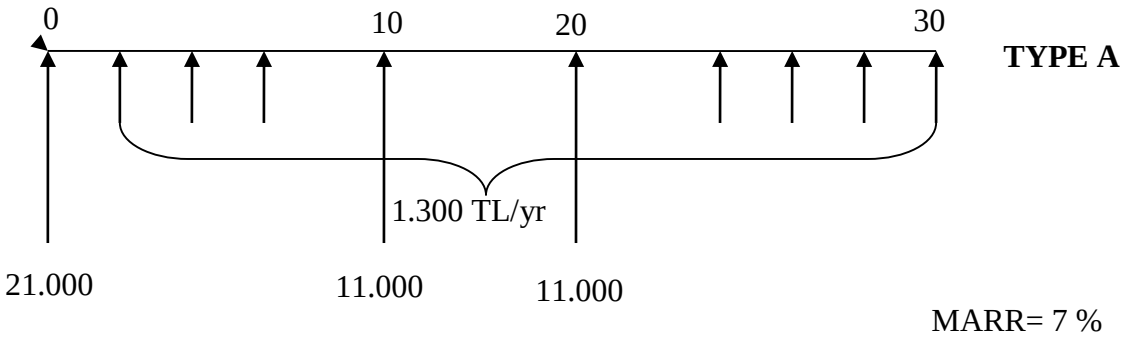
$$n = 12 + \frac{0,155}{0,23} = 12,67 \text{ yrs}$$

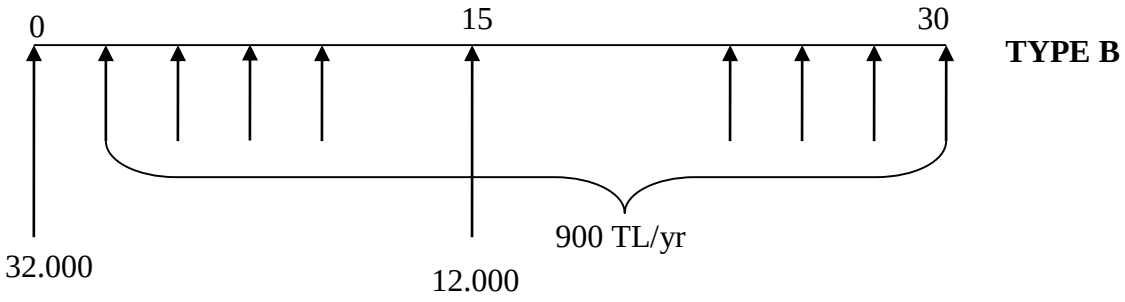
PROBLEM 2

Two possible types of road surface are being considered with cost estimates per mile as follows:

	Type A	Type B
First cost	21.000 TL	32.000 TL
Resurfacing period	10 yrs	15 yrs
Resurfacing cost	11.000 TL	12.000 TL
Average annual upkeep cost	1.300 TL	900 TL

The period resurfacings will involve replacement only of the wearing surface and not of the base or surface.
Compare these on the basis of the present worth of the cost of 30 years service, assuming zero terminal salvage value for both types at the end of 30 years and using MARR of 7 %.





ALT A

$PW_A(7) = - 21.000 – 11.000 (P/F,7\%,10) – 11.000 (P/F,7\%,20) – 1.300 (P/A,7\%,30)$

$= - 21.000 – 11.000 * 0,5083 – 11.000 * 0,2584 – 1.300 * 12,409$

$PW_A(7) = - 45.565,4$ TL

ALT B

$PW_B(7) = - 32.000 – 12.000 (P/F,7\%,15) - 900 (P/A,7\%,30)$

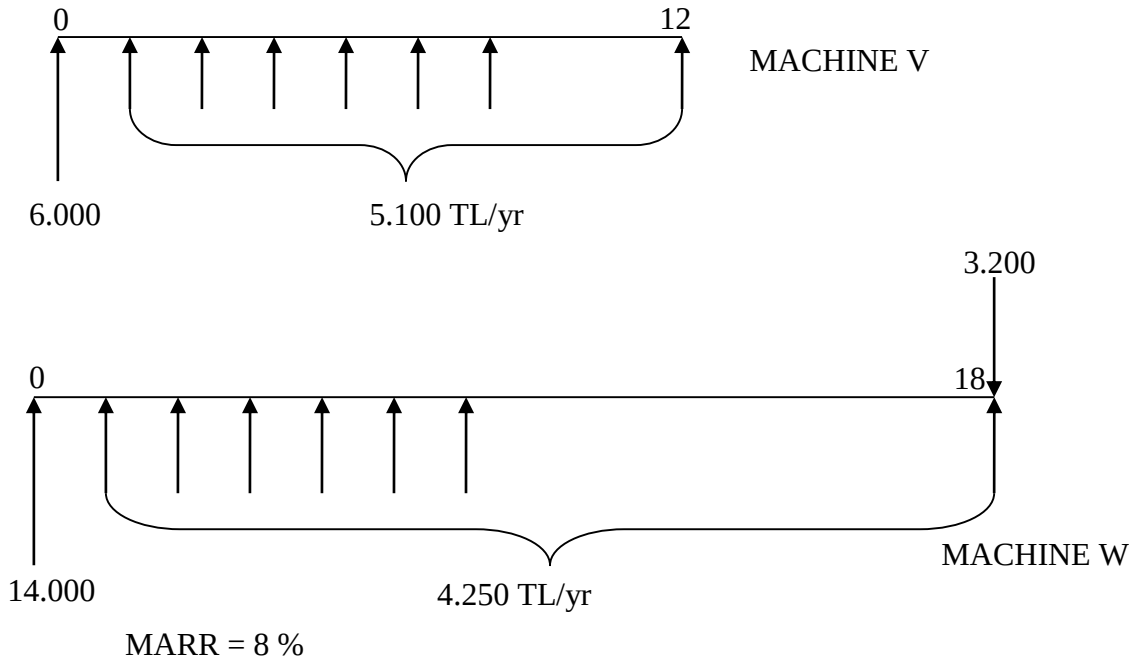
$= - 32.000 – 12.000 * 0,3624 – 11.000 * 0,2584 – 900 * 12,409$

$PW_B(7) = - 47.516,9$ TL

CHOOSE ALT A

PROBLEM 3

A certain service can be performed satisfactorily either by Machine V or W. Machine V has a first cost of 6.000 TL, an estimated life of 12 years with zero salvage value and annual disbursements of 5.100 TL. The corresponding figures for Machine W are 14.000 TL, 18 years, 3.200 TL salvage value and 3.500 TL, extra annual disbursement with Machine W is estimated to be 750 TL. Compare the annual costs assuming a MARR of 8 %.



$AE_V(8)$ $= - 6.000 (A/P, 8\%, 12) – 5.100$

$= - 6.000 * 0,13270 – 5.100$

$= - 5.896,2$ TL/ yr

AEw(8) = - 14.000 (A/P, 8%, 18) – 4.250 + 3.200 (A/F, 8%, 18)

= - 14.000 * 0,1067 – 4.250 + 3.200 * 0,02670

= - 5.743,8 + 85,44

= - 5.657,72 TL/ yr

CHOOSE MACHINE W

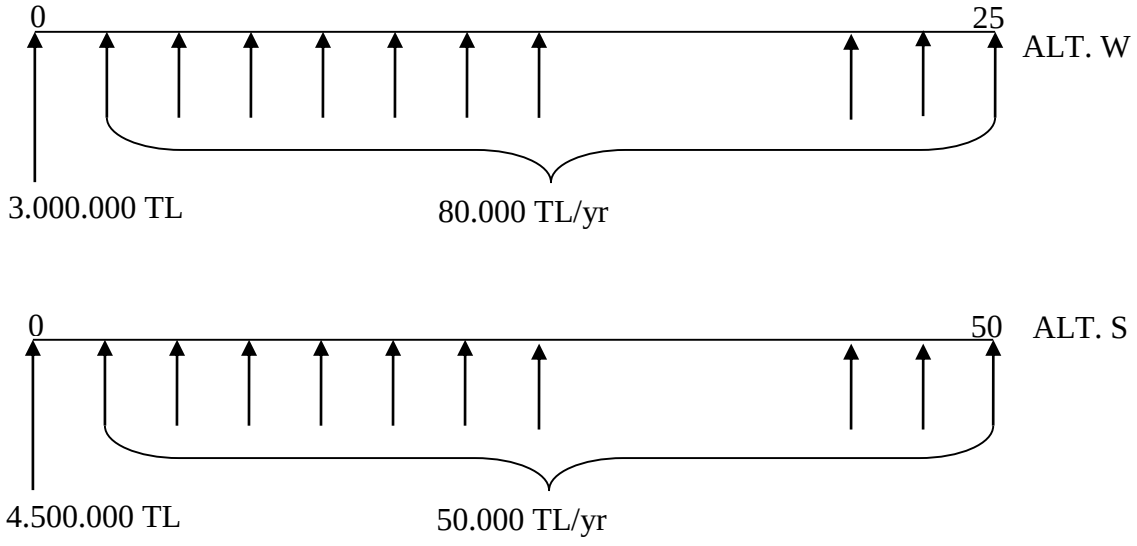
PROBLEM 4

A company is considered whether to build a wood or steel warehouse to satisfy its storage space requirement. A wood structure, with an expected life of 25 years, will cost 3.000.000 TL and a steel structure, with an expected life of 50 years, will costs 4.500.000 TL. Expected average annual maintenance costs are 80.000 TL for the wood structure and 50.000 TL for the steel building. By adopting the annual equivalence comparison method, determine whether a wood or a steel structure is more desirable if:

a) The company's requirement for the storage space is for 25 years only.
b) The company's requirement for the storage space will be more than 50 years.

Use the interest rate as 15 %.

CALL THE "WOOD STRUCTURE" AS ALTERNATIVE W, AND THE "STEEL STRUCTURE" AS ALTERNATIVE S.



A) Since the structure is needed for 25 years only, one should consider the life of steel structure as 25 years . It is assumed that the steel warehouse will not bring any profit after 25 years of service.

AE_W (15) = - 3.000.000 (A/P, 15%, 25) – 80.000

= - 3.000.000 * 0,1547 – 80.000

= - 544.100 TL

AE_S (15) = - 4.500.000 (A/P, 15%, 25) – 50.000

= - 4.500.000 * 0,1547 – 50.000

= - 746.150 TL

SELECT WOOD STRUCTURE

B) Since the structure is needed for 50 years, a new wood warehouse should be built after 25 years.

AE_W (15) = - 544.100 TL As in part A.

AE_S (15) = - 4.500.000 (A/P, 15%, 50) – 50.000

= - 4.500.000 * 0,15014 – 50.000

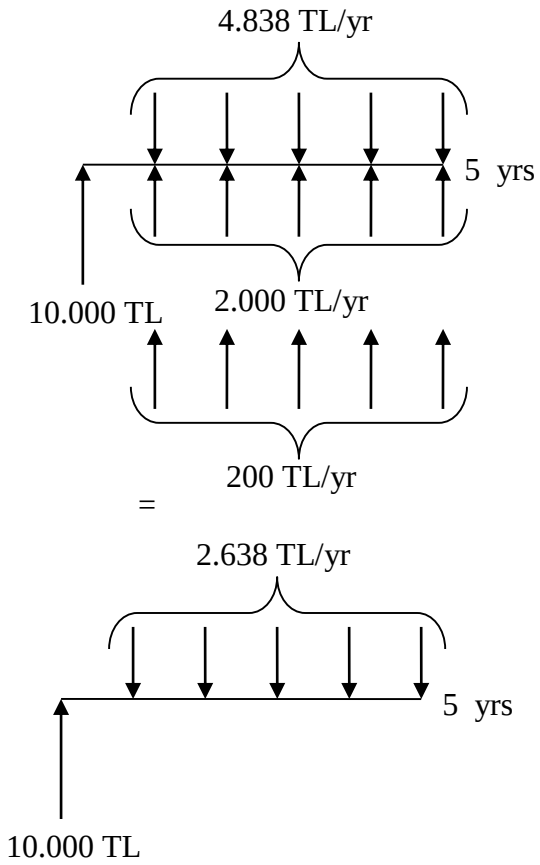
= - 725.630 TL

CHOOSE WOOD STRUCTURE

PROBLEM 5

An investment of 10.000 TL can be made in a fully depreciable (i.e., no salvage value) project that will produce a uniform annual revenue of 4.838 TL for 5 years. From this revenue, 2.000 TL per year will have to be paid for operation and maintenance costs are 200 TL per year for property taxes and insurances. The company is willing to accept any project which will earn 10 % or more, on all invested capital. Show whether this is a desirable investment using:

- **a)** The present worth comparison
- **b)** The annual equivalent comparison
- **c)** The rate of return comparison



A) PW COMPARISON

PW (10) = - 10.000 + 2.638 (P/A,10%,5)

= - 10.000 + 2.638 * 3,7908

≈ 0,0

UNDESIRABLE

B) ANNUAL EQUIVALENT

AE (10) = - 10.000 (A/P, 10%, 5) + 2.638

= - 10.000 * 0,2638 + 2.638

= - 2.638 + 2.638 = 0

C) RATE OF RETURN COMPARISON

PW (i^*) = 0 = - 10.000 + 2.638 (P/A, i^*, 5)

$(P/A,i^*,5) = \frac{10.000}{2.638} = 3,791$

i^* = MARR

i = 5 (P/A, 5%, 5) = 4,3295

i = 10 (P/A, 10%, 5) = 3,7908

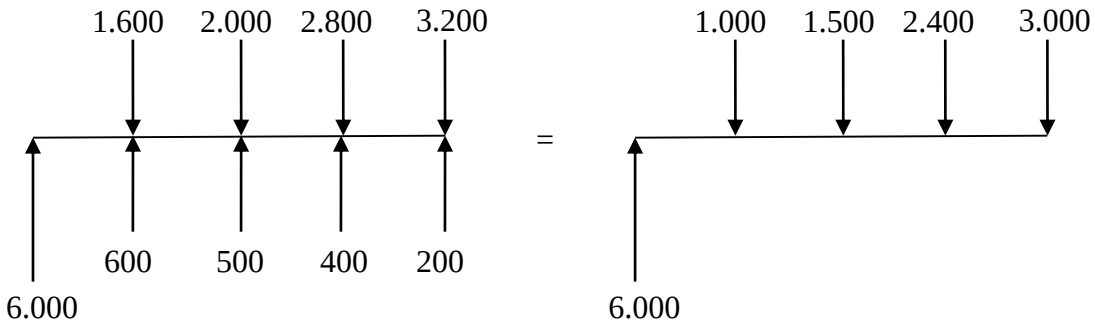
PROBLEM 6

A prospective venture is described by the following receipts and disbursements:

Year End	Receipts	Disbursements
0	0 TL	6.000 TL
1	1.600 TL	600 TL
2	2.000 TL	500 TL
3	2.800 TL	400 TL
4	3.200 TL	200 TL

For an interest rate of 12 % determine the desirability of the venture on the basis of:

a) The present worth comparison
b) The annual equivalent comparison
c) The rate of return comparison



A) PW(12) = -6.000 + 1.000(P/F,12,1) + 1.500(P/F,12,2) + 2.400(P/F,12,3) + 3.000(P/F,12,4)

PW(12) = -6.000 + 1.000*0,8929 + 1.500*0,7972 + 2.400*0,7118 + 3.000*0,6355

= -6.000 + 5.703,52

= -296,48 NOT DESIRABLE

B) ANNUAL EQUIVALENT OF DISBURSEMENT

D_A = 6.000 * (A/P,12,4) = 6.000 * 0,32923 = 1.975,38

ANNUAL EQUIVALENT OF RECEIPTS

R_A = 5.703,52 (A/P,12,4) = 5.703,52 * 0,32923 = 1.877,77

SINCE $R_A < D_A$ NOT DESIRABLE

C) DO NOTHING: CURRENT BEST

ALTERNATIVE: CHALLENGER

i = 12 %

PW(i^*)= 0 = -6.000 + 1.000(P/F, i^*,1) + 1.500(P/F, i^*,2) + 2.400(P/F, i^*,3) + 3.000(P/F, i^*,4)

PW(12) = -296,48

i^*= 10 %

PW(10) = -6.000 + 1.000(P/F,10,1) + 1.500(P/F,10,2) + 2.400(P/F,10,3) + 3.000(P/F,10,4)

PW(10) = -6.000 + 1.000 * 0,9091 + 1.500 * 0,8264 + 2.400 * 0,7513 + 3.000 * 0,6830
PW(10) = -6.000 + 909,1 + 1.239,6 + 1.803,12 + 2.049 = -6.000 + 6.000,82 = +0,82

$$i^* = 10 + 2 * \frac{0,82}{(296,48 + 0,82)} = 10 + 0,0055 < 12\ \%$$

SELECT DO NOTHING

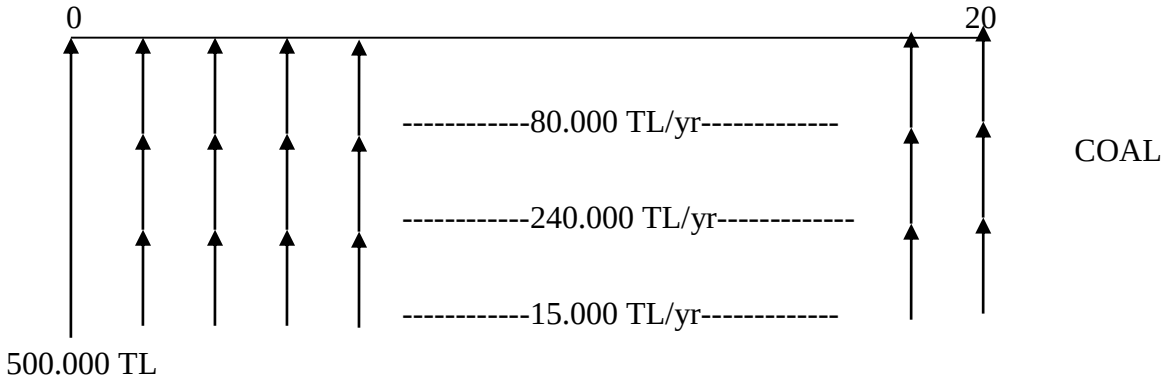
PROBLEM 7

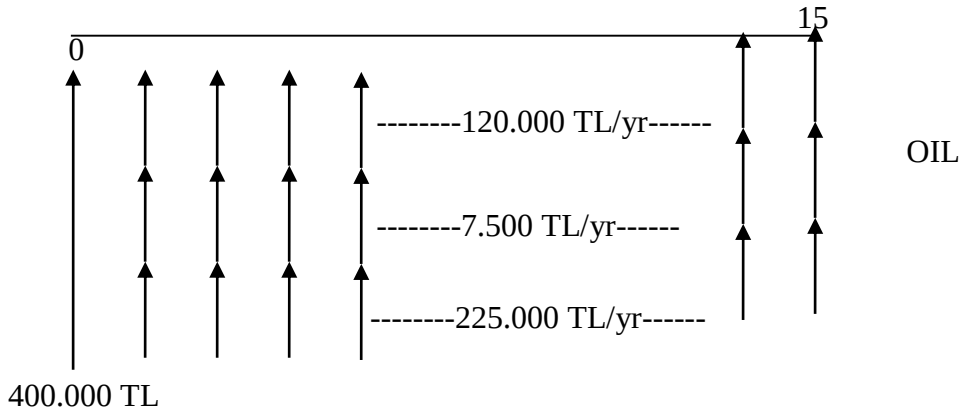
A city must build a new steam plant to supply heat for a new municipal building. Two types of buildings are being considered:

One would burn coal and would cost 500.000 TL. It would consume 800 tons of coal annually at a cost of 100 TL per ton. Annual labor costs for this plant would be 240.000 TL and the maintenance costs are estimated to be 15.000 TL per year.

An alternative plant would burn oil and would cost 400.000 TL. The labor and maintenance costs for this plant are estimated to be only one half as much as for the coal-burning plant. Fuel oil would cost 45 TL per barrel, and 5.000 barrels would be consumed annually. This plant would have an estimated life of 15 years, whereas the coal plant would last 20 years.

Which type of plant would you recommend if the interest rate is 6 %. Solve the problem by using both the present worth and annual equivalent methods.





A) ANNUAL EQUIVALENT METHOD

$AE_{COAL}(6)$ = -80.000 – 240.000 – 15.000 – 500.000(A/P,6%,20)

= - 335.000 – 500.000 * 0,08716

= - 335.000 – 43.590

= - 378.590 TL/yr

$AE_{OIL}(6)$ = -120.000 – 7.500 – 225.000 – 400.000(A/P,6%,15)

= - 352.500 – 400.000 * 0,10296

= - 352.500 – 41.184

= - 393.684 TL/yr

SELECT COAL PLANT WHICH HAS MINIMUM ANNUAL COST!

B) PRESENT WORTH METHOD:

COMMON MULTIPLE: 60 YEARS

$PW_{COAL}(6)$ = -378.590 (P/A,6%,60)

= -378.590 * 16,161

= -6.118.392,99 TL

$PW_{OIL}(6)$ = -393.684 (P/A,6%,60)

= -393.684 * 16,161

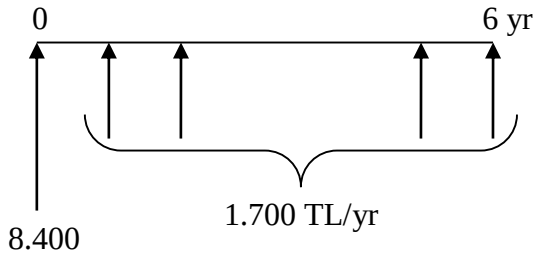
= -6.362.327,12 TL

SELECT COAL PLANT WHICH HAS MINIMUM PRESENT-WORTH COST!

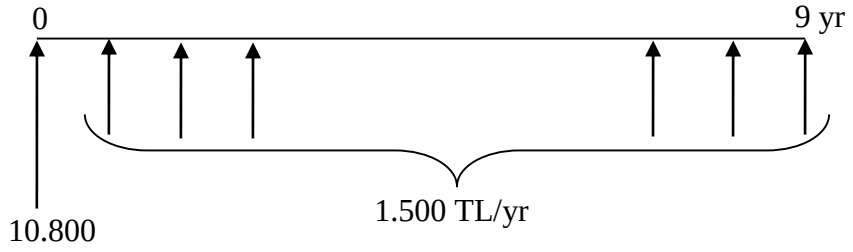
PROBLEM 8

Two types of heat exchanger are compared for service in a chemical plant. Type Y has a first cost of 8.400 TL, an estimated life of 6 years with zero salvage value and annual operating costs of 1.700 TL. Type Z has a first cost of 10.800 TL, an estimated life of 9 years with zero salvage value, and annual operating costs of 1.500 TL.

Compare them with i = 10 %.



Y



Z

i = 10 %

AE_Y (10) = -8.400 (A/P, 10%, 6) – 1.700

= - 8.400 * 0,22961 – 1.700

= - 1.928,72 – 1.700 = -3.628,72 TL/6 yrs

AE_Z (10) = -10.800 (A/P, 10%, 9) – 1.500

= -10.800 * 0,17364 – 1.500

= - 1.875,31 – 1.500 = -3.375,31 TL/9 yrs

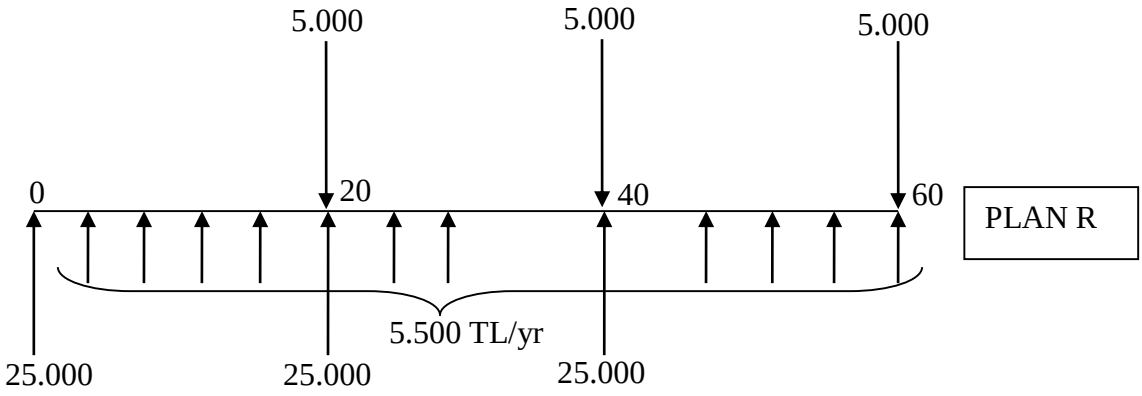
CHOOSE Z !

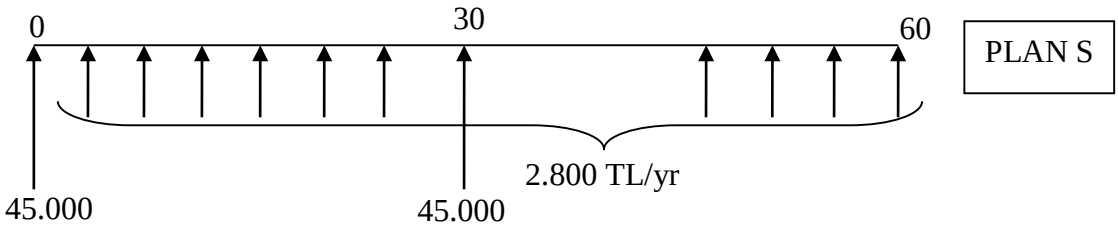
PROBLEM 9

Estimates for alternative plans in the design of certain industrial facilities are:

	Plan R	Plan S
First cost……..	25.000 TL	45.000 TL
Life……..	20 years	30 years
Salvage value……..	5.000 TL	None
Annual disbursements……..	5.500 TL	2.800 TL

Using a MARR of 8 %, compare the two plans using present worth method. Assume that the replacement facilities in both plans will have the same first cost, lives, salvage values, annual disbursements as the initial facilities.





MARR = 8 %

$PW_R(8)$ = -25.000 – 25.000(P/F,8%,20) – 25.000(P/F,8%,40) + 5.000(P/F,8%,20) +

5.000(P/F,8%,40) + 5.000(P/F,8%,60) – 5.500(P/A,8%,60)

= -25.000 – 25.000*0,2145 – 25.000*0,0460 + 5.000*0,2145 +

5.000*0,0460 + 5.000*0,0098 – 5.500*12,3766

= -25.000 – 5.362,5 – 1.150 + 1.072,5 + 230 – 68.071,3

= -98.232,3 TL

$PW_S(8) = -45.000 – 45.000(P/F,8\%,30) – 2.800(P/A,8\%,60)$

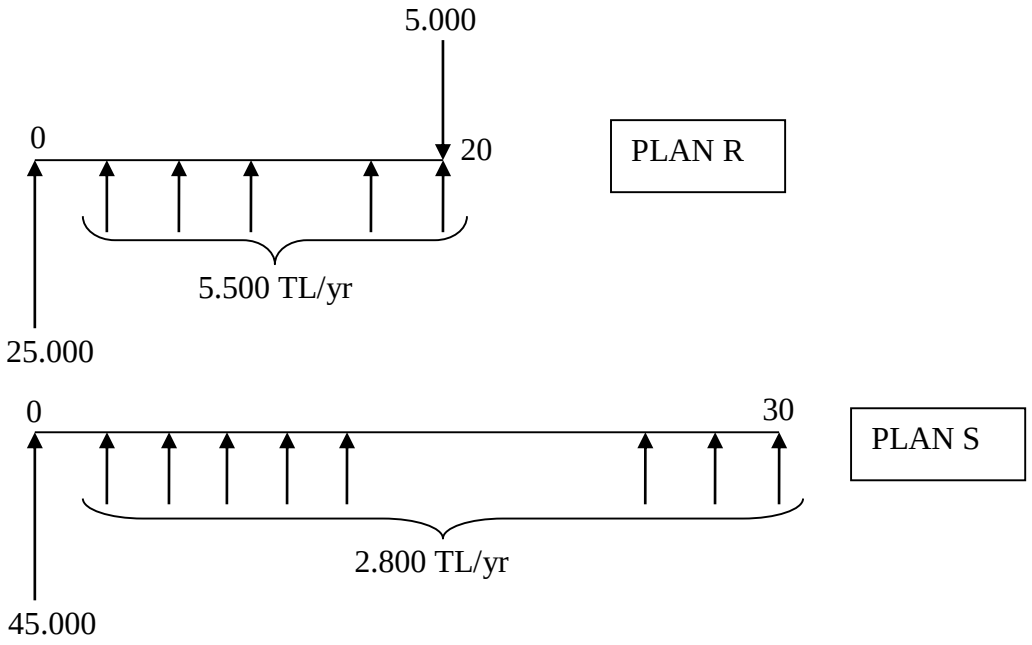
$= -45.000 – 45.000*0,0993 – 2.800*12,3766$

$= -45.000 – 4.468,5 – 34.654,48$

$= -84.122,98$ TL

CHOOSE PLAN S!

SOLUTION 9 (ALTERNATIVE SOLUTION)



$AE_R(8) = - 25.000(A/P,8\%,20) – 5.500 + 5.000(A/F,8\%,20)$

$= - 25.000*0,1019 – 5.500 + 5.000*0,0219$

$= -2.547,50 – 5.500 + 5.000 + 109,50$

$= -7.938$ TL/yr

$AE_S(8) = - 45.000(A/P,8\%,30) – 2.800$

$= - 45.000*0,0888 – 2.800$

$= -3.996 – 2.800$

$= -6.796$ TL/yr

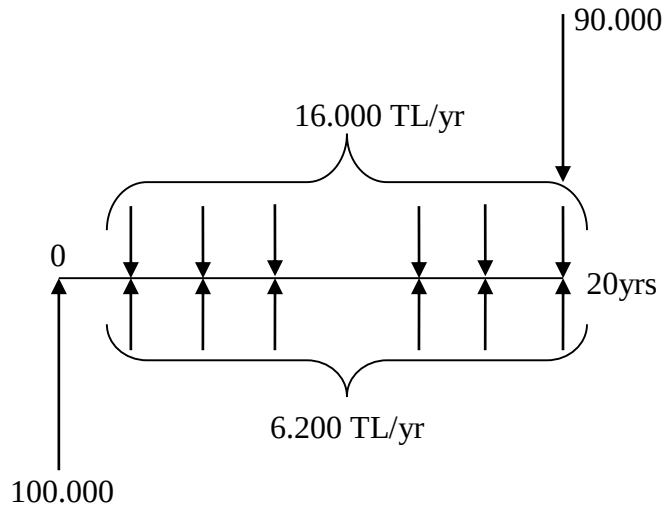
$PW_R(8) = 7.938(P/A,8\%,60) = 7.938*12,3766 = -98.245,45$ TL

$PW_S(8) = 6.796(P/A,8\%,60) = 6.796*12,3766 = -84.111,37$ TL

CHOOSE PLAN S!!

PROBLEM 10

The first cost of a piece of business property containing stones and offices is 100.000 TL. A prospective investor estimates that annual receipts from rentals will be 16.000 TL and that annual disbursements will be 6.200 TL. He also estimates that the property will be saleable for a net 90.000 TL at the end of 20 years. What is his rate of return if he purchases the property at this price and holds for 20 years?



$AE(i^*) = -100.000\ (A/P,i^*,20) + 9.800 + 90.000(A/F,i^*,20) = 0$

$9.800 + 90.000(A/F,i^*,20) = 100.000\ (A/P,i^*,20)$

$i^* = 8\ \% \longrightarrow 9.800 + 90.000*0,02185 = 100.000*0,10185$

$9.800 + 1.966,5 = 10.185$

$11.766,50 \neq 10.185$

$i^* = 9\ \% \longrightarrow 9.800 + 90.000*0,0196 = 100.000*0,1096$

$9.800 + 1.764 = 10.960$

$11.564 > 10.960 \longrightarrow 604,00$

$i^* = 10\ \% \longrightarrow 9.800 + 90.000*0,01746 = 100.000*0,11746$

$11.371,40 < 11.746 \longrightarrow -374,60$

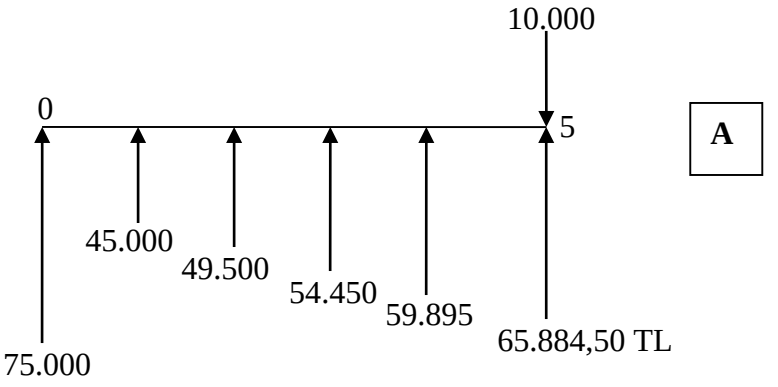
$$i^* = 9 + 1 * \frac{604}{604 + 374,60} = 9,6172\ \%$$

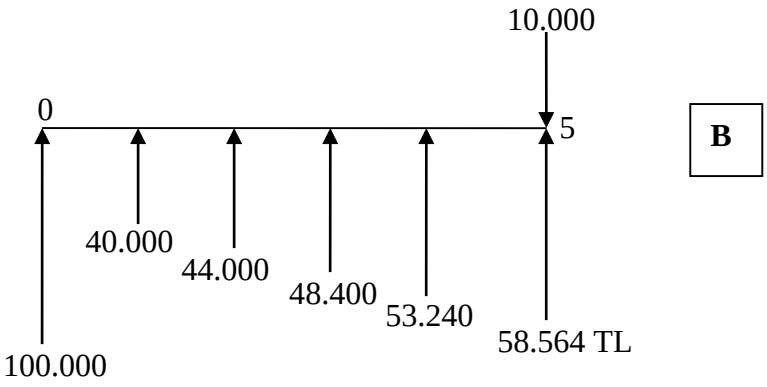
PROBLEM 11

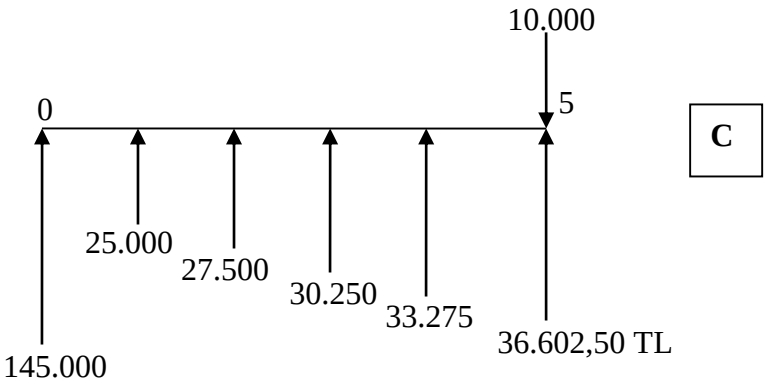
A contracting company must purchase a new truck, equipped with a hydraulic crane. Bids for three types of equipment have been received. The required initial investments are the estimated annual out of packet disbursements for the first year are as follows:

	A	B	C
Initial Investment (TL)	75.000	100.000	145.000
Out of packet Costs(TL)	45.000	40.000	25.000

The company believes that the out of packet disbursements each year will be 10 % more than the previous year. The company wants a period of not over 5 years to be used on such equipment and MARR = 15 %. Determine which type of equipment should be purchased by using the rate of return comparison method. Assume 10.000 TL salvage value for each type of equipment.

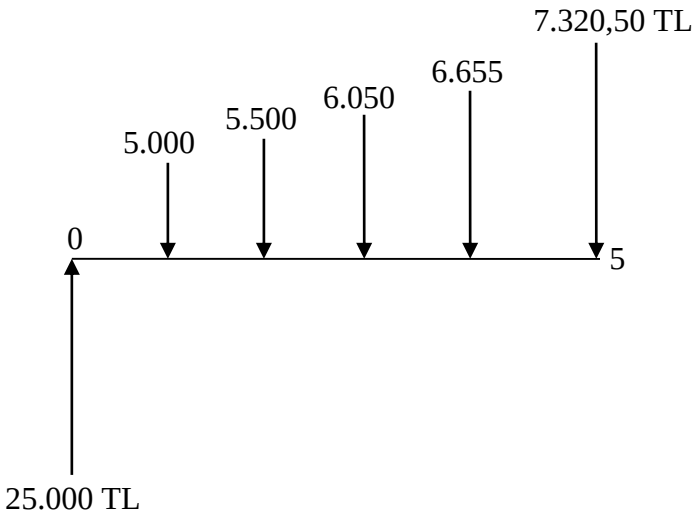






A) CURRENT BEST: A

CHALLENGER: B



B - A

$PW(i^*) = 0$

$PW_{B-A}(i^*) = 5.000(P/F, i^*,1) + 5.500(P/F, i^*,2) + 6.050(P/F, i^*,3) + 6.655(P/F, i^*,4) +$

$7.320,50(P/F, i^*,5) – 25.000$

LET $i^* = 2\ \%$

$PW_{B-A}(2) = 5.000*0,9804 + 5.500*0,9612 + 6.050*0,9423 + 6.655*0,9238 +$

$7.320,50*0,9057 – 25.000$

$= 4.902 + 5.286,60 + 5.700,92 + 6.147,89 + 6.630,18 – 25.000$

$= 3.667,59$ TL

LET $i^* = 3\ \%$

$PW_{B-A}(3) = 5.000*0,9709 + 5.500*0,9426 + 6.050*0,9151 + 6.655*0,8885 +$

$7.320,50*0,8626 – 25.000$

$= 4.854,50 + 5.184,30 + 5.536,36 + 5.912,97 + 6.314,66 – 25.000$

$= 2.802,79$ TL

LET $i^* = 5\ \%$

$PW_{B-A}(5) = 5.000*0,9524 + 5.500*0,9070 + 6.050*0,8638 + 6.655*0,8217 +$

$7.320,50*0,7835 – 25.000$

$= 4.762 + 4.988,50 + 5.225,99 + 5.475,07 + 5.735,61 – 25.000$

$= 1.187,17$ TL

LET $i^* = 6\ \%$

$PW_{B-A}(6) = 5.000*0,9434 + 5.500*0,8900 + 6.050*0,8396 + 6.655*0,7921 +$

$7.320,50*0,7473 – 25.000$

$= 433,62\ TL$

LET $i^* = 7\ \%$

$PW_{B-A}(7) = 5.000*0,9346 + 5.500*0,8734 + 6.050*0,8163 + 6.655*0,7629 +$

$7.320,50*0,7130 – 25.000$

$= -288,07\ TL$

1 %	(433,62 + 288,07) = 721,69
X	433,62

$$X = \frac{433,62}{721,69} = 0,60$$

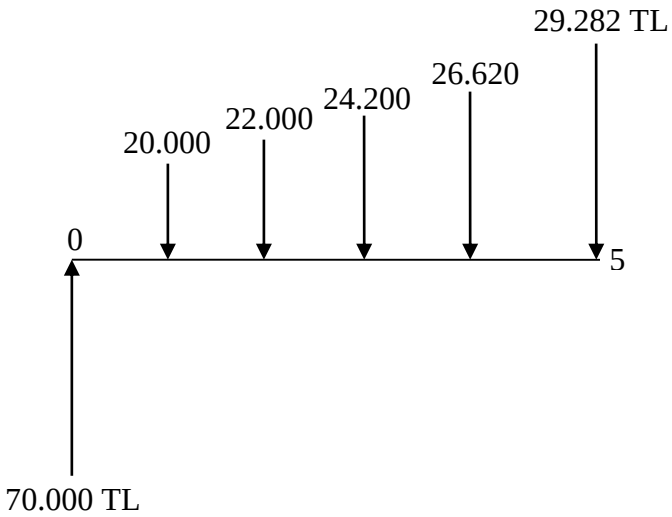
$i^* = 6,60\ \% \quad < \quad MARR = 15\ \%$

CURRENT BEST "**A"** REMAINS CURRENT BEST

CHALLENGER "**B**" IS ELIMINATED

B) CURRENT BEST: A

CHALLENGER: C



C - A

$PW(i^*) = 0$

$PW_{C-A}(i^*) = 20.000(P/F, i^*,1) + 22.000(P/F, i^*,2) + 24.200(P/F, i^*,3) + 26.620(P/F, i^*,4) + 29.282(P/F, i^*,5) – 70.000$

LET $i^* = 12\ \%$

$PW_{C-A}(12) = 20.000*0,8929 + 22.000*0,7972 + 24.200*0,7118 + 26.620*0,6355 + 29.282*0,5674 – 70.000$

$= 16.153,58$ TL

LET $i^* = 15\ \%$

$PW_{C-A}(15) = 20.000*0,8696 + 22.000*0,7561 + 24.200*0,6575 + 26.620*0,5718 + 29.282*0,4972 – 70.000$

$= 9.718,03$ TL

$i^* > MARR = 15\%$

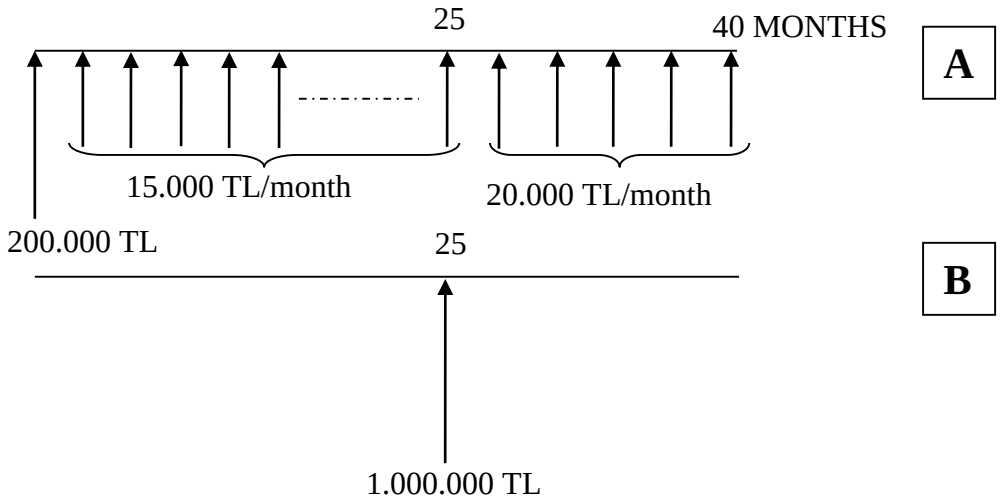
CHALLENGER BECOMES CURRENT BEST AND **“C”** IS SELECTED.

PROBLEM 12

A concrete mixer manufacturer offers two selling programmes. In the first programme called programme A, the buyer must deposit an initial payment of 200.000 TL now, and he must make monthly deposits of 15.000 TL/month for 25 months. At the end of 25th month he is going to be owner of the concrete mixer but is going to make monthly deposits of 20.000 TL/month for a further 15 months.

The second programme called programme B is simpler. The buyer pays a single sum of 1.000.000 TL, at the end of 25 months from now and takes possession of the concrete mixer. There are no monthly payments in this programme.

Assuming a MARR of 15 % per year and by using the rate of return method of comparison, determine which programme is economically desirable as far as the buyer is concerned. Use the value at the end of the 25th in your rate of return calculations.



$i = (1 + i_m)^{12} - 1$

$0{,}15 = (1 + i_m)^{12} - 1$

$(1 + i_m)^{12} = 1{,}15$

$1 + i_m = 1{,}0117$

$i_m = 0{,}0117$

$i_m = 1{,}17\ \%$

CURRENT BEST = B
CHALLENGER = A

V= -200.000(F/P,i_m^*, 25) - 15.000(F/A,i_m^*, 25) - 20.000(P/A,i_m^*, 15) + 1.000.000

$$V= -200.000\left(1+i_m^*\right)^{25} - 15.000\left[\frac{\left(1+i_m^*\right)^{25}-1}{i_m^*}\right] - 20.000\left[\frac{\left(1+i_m^*\right)^{15}-1}{i_m^*\left(1+i_m^*\right)^{15}}\right] + 1.000.000$$

V= (-200.000*1,3375) – (15.000*28,8461) – (20.000*13,6844) + 1.000.000
V= -267.500 – 432.691,50 – 273.688 +1.000.000

V= -973.879,50 + 1.000.000

V= 20.120,50

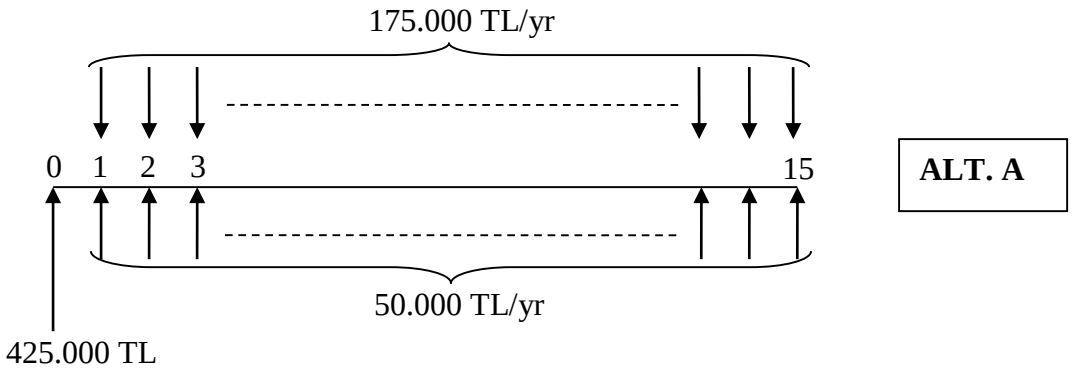
i* > MARR ⟶ SELECT **A**

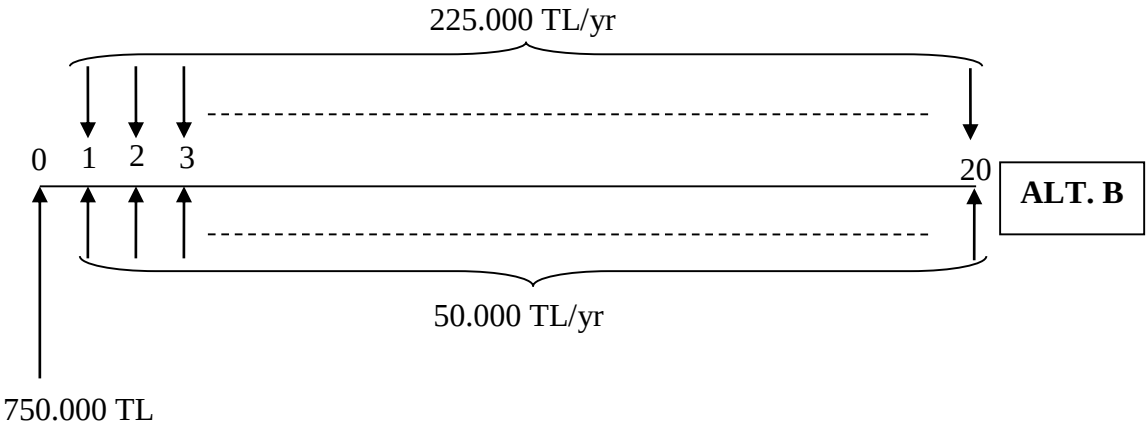
PROBLEM 13

Two alternatives A and B are to be considered in the construction of a water tank. The following information is given for these alternatives:

	ALTERNATIVE A	ALTERNATIVE B
Initial cost	425.000 TL	750.000 TL
Yearly expenditure	50.000 TL/yr	50.000 TL/yr
Yearly income	175.000 TL/yr	225.000 TL/yr
Estimated life	15 yrs	20 yrs
MARR	15%	15%

Which alternative is more economical? Use the rate of return method of comparison, and the present worth approach.





MARR 15 %

Rate of return method, present worth approach

Common multiple of lives: 60 years

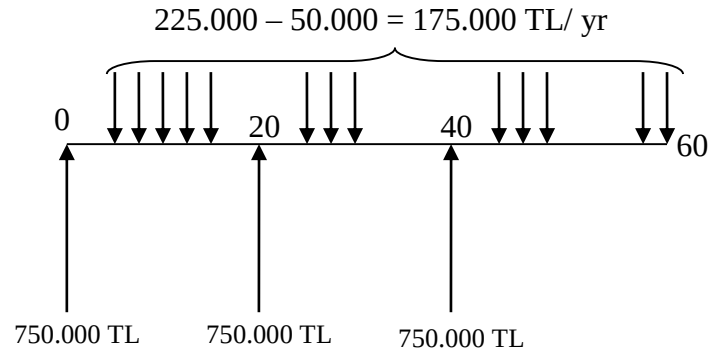
Step1: Ascending order of their first costs:
ALT. A, ALT. B

Step 2: Initial "Current best" alternative: **ALT. A**

Step 3: Current best: **ALT. A**

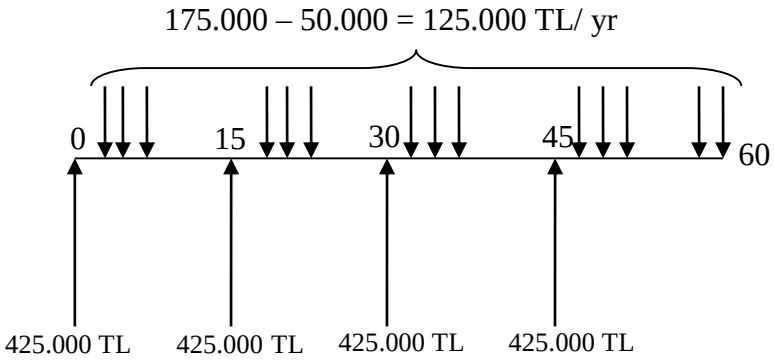
Challenger : **ALT. B**

Step 4: Challenger – Current Best



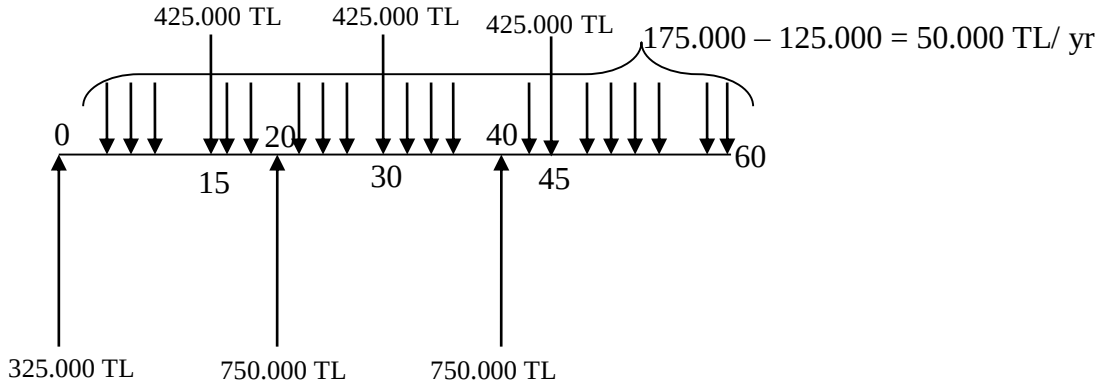
ALT. B

—



ALT. A

——
——



ALT. B - ALT. A

$PW_{ALT.B}(i^*) - PW_{ALT.A}(i^*) = 0$

$AE_{ALT.A}(i^*) = -425.000(A/P, i^*, 15) + 125.000$

$AE_{ALT.B}(i^*) = -750.000(A/P, i^*, 20) + 175.000$

$PW_{ALT.A}(i^*) = AE_{ALT.A}(i^*)(P/A, i^*, 60) = [-425.000(A/P, i^*, 15) + 125.000] (P/A, i^*, 60)$

$PW_{ALT.B}(i^*) = AE_{ALT.B}(i^*)(P/A, i^*, 60) = [-750.000(A/P, i^*, 20) + 175.000] (P/A, i^*, 60)$

$PW_{ALT.B}(i^*) - PW_{ALT.A}(i^*) = [-750.000(A/P, i^*, 20) + 175.000] (P/A, i^*, 60) - [-425.000(A/P, i^*, 15) + 125.000] (P/A, i^*, 60) = 0$

$[-750.000(A/P, i^*, 20) + 175.000 + 425.000(A/P, i^*, 15) - 125.000](P/A, i^*, 60) = 0$

LET $i^* = 10\ \%$

$[-750.000*0{,}11746 + 175.000 + 425.000*0{,}13147 - 125.000](9{,}967) = 177.210{,}76$

LET $i^* = 15\ \%$

$$[-750.000*0{,}15976 + 175.000 + 425.000*0{,}17102 - 125.000]\left[\frac{(1+0{,}15)^{60}-1}{0{,}15(1+0{,}15)^{60}}\right] = 19.085{,}22$$

LET $i^* = 20\ \%$

$$[-750.000*0{,}20536 + 175.000 + 425.000*0{,}21388 - 125.000]\left[\frac{(1+0{,}20)^{60}-1}{0{,}20(1+0{,}20)^{60}}\right] = -65.603{,}69$$

$i^* = 16{,}13\ \%$ (by interpolation) > MARR= 15 %

ALT. A is eliminated!

Select ALT. B

OR:

$PW_{ALT.B}(15) - PW_{ALT.A}(15) = [-750.000(A/P,15, 20) + 175.000] (P/A, 15, 60) –$

$[-425.000(A/P, 15, 15) + 125.000] (P/A, 15, 60) = 19.085{,}22$

Select ALT. B

ALTERNATIVE SOLUTION:

$PW_{B-A}(i^* = 15) = [-325.000 + 425.000(P/F, i^*, 15) + 425.000(P/F, i^*, 30) + 425.000(P/F, i^*, 45)$
$0,1229 \qquad 0,0151 \qquad 0,0019$

$- 750.000(P/F, i^*, 20) - 750.000(P/F, i^*, 40) + 50.000(P/A, i^*, 60) = 0$
$0,0611 \qquad 0,0037 \qquad 333.257,65$
(from the formula)

$PW_{B-A}(i^* = 15) = +19.114$ TL

i^* FOR $(A_2 - A_1) >$ MARR

A_1 IS ELIMINATED CHOOSE A_2(B)

PROBLEM 14

A student who succeeded in the University Entrance examination is faced with two alternatives.

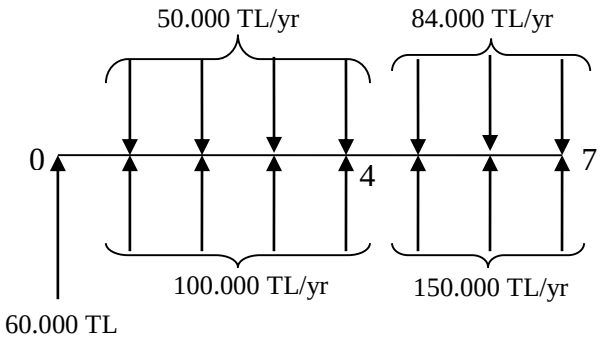
1. Entering the Istanbul University
2. Entering the Ankara University

The income and expenditures estimated for these two alternatives are tabulated below:

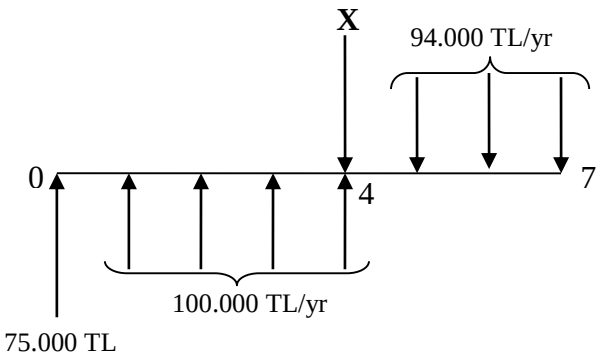
Tuition and Administrative Expenses (paid once at the beginning of BS education)	**ALTERNATIVE A** **60.000 TL**	**ALTERNATIVE B** **75.000 TL**
Annual Expenditure during BS Education	100.000 TL/year	100.000 TL/year
Annual Income during BS Education (scholarship)	50.000 TL/year	-
Duration of BS Education	4 years	4 years
Duration of MS Education	3 years	3 years
Annual Expenditure during MS Education	150.000 TL/year	-
Annual Income during MS Education	84.000 TL/year	94.000 TL/year

a) If MARR: 25% which alternative will be more desirable. Solve the problem by using incremental rate of return method of comparison. Use annual equivalent values in your calculations.

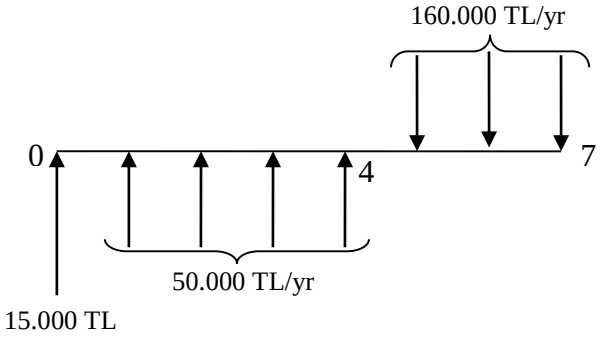
b) What single payment X should this student receive at the end of his BS education in the undesirable alternative so that both alternatives are equivalent? MARR: 25 %. Use present worth values in your calculation.



ALT. 1 **ISTANBUL**



ALT. 2 **ANKARA**



ALT. 2 - ALT. 1

a) CURRENT BEST: ALT 1

CHALLENGER: ALT 2

$AE_{2-1}(25)$= -15.000(A/P,25,7) – 50.000(P/A,25,4) (A/P,25,7) + 160.000(F/A,25,3)(A/F,25,7)

$AE_{2-1}(25)$= -15.000(0,31634) – 50.000(2,362) (0,31634) + 160.000(3,813)(0,06634)

$AE_{2-1}(25)$= -4.745,10 – 37.359,75 +40.472,71

$AE_{2-1}(25)$= -1.632,14 TL/ yr

$AE_{2-1}(20)$= -15.000(A/P,20,7) – 50.000(P/A,20,4) (A/P,20,7) + 160.000(F/A,20,3)(A/F,20,7)

$AE_{2-1}(20)$= -15.000(0,27142) – 50.000(2,589) (0,27742) + 160.000(3,640)(0,07742)

$AE_{2-1}(20)$= -4.161,30 – 35.912,02 +45.089,41

$AE_{2-1}(20)$= +5.016,09 TL/ yr

SELECT **ALT.1 ISTANBUL**

b) $PW_1(25)$= -60.000 – (100.000 – 50.000)(P/A,25,4) – (150.000 - 84.000)(P/A,25,3)(P/F,25,4)

$PW_1(25)$= -60.000 – (50.000)(2,362) – (66.000)(1,952)(0,4096)

$PW_1(25)$= -60.000 – 118.100 – 52.769,59

$PW_1(25)$= -230.869,59 TL

$PW_2(25)$= -75.000 – (100.000)(P/A,25,4) + (94.000)(P/A,25,3)(P/F,25,4) + X(P/F,25,4)

$PW_2(25)$= -75.000 – (100.000)(2,362) + (94.000)(1,952)(0,4096) + X(0,4096)

$PW_2(25)$= -236.043,31 + (0,4096)X

$PW_1(25) = PW_2(25)$

-230.869,59 = -236.043,31 + (0,4096)X

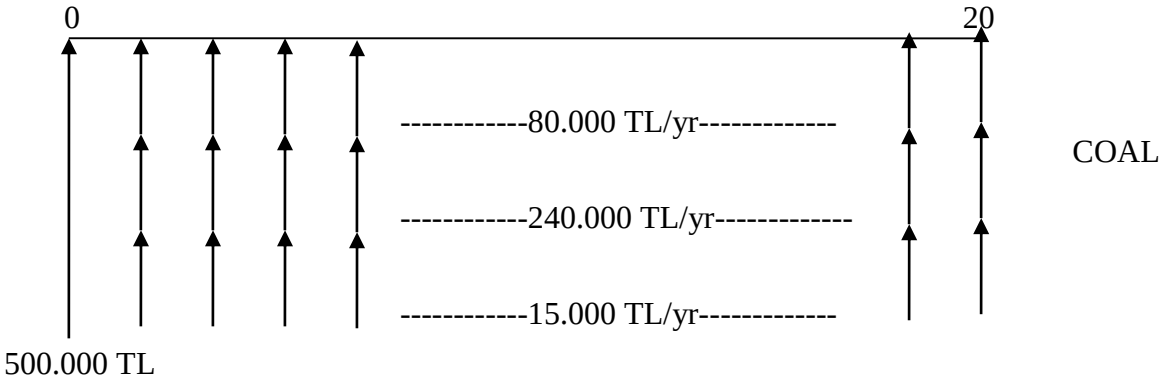
$$X = \left[\frac{(23604,31 - 23086,59)}{0,4096}\right] = \left[\frac{(517,72)}{0,4096}\right]$$

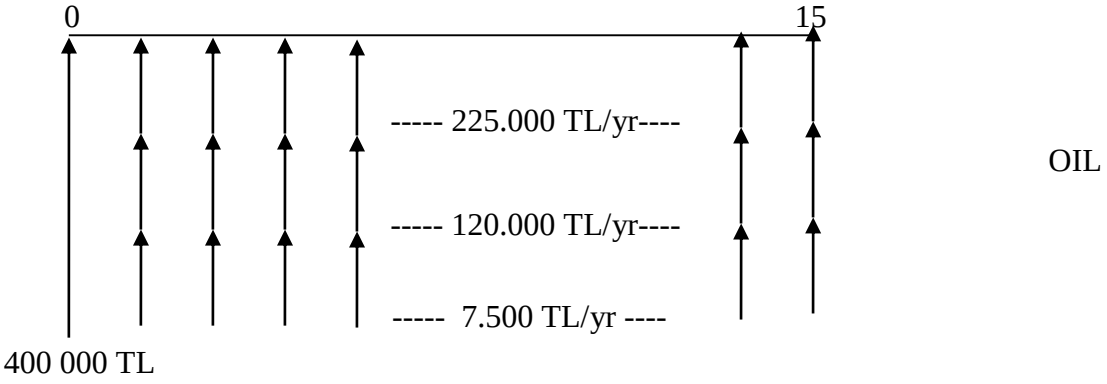
PROBLEM 15

Two types of heating systems are considered for a factory building. First type, would burn coal and would have an initial cost of 500.000 TL. It would consume 800 tons of coal annually, at a cost of 100 TL per ton. Annual labor costs for this plant would be 240.000 TL/yr and the maintenance costs are estimated to be 15.000 TL/yr.

The second type, would burn fuel oil and would have an initial cost of 400.000 TL. The labor and maintenance costs for this plant are estimated to be half of the labor and maintenance costs of coal burning plant. Fuel oil would cost 45 TL per barrel, and 5000 barrels would be consumed annually. Fuel oil burning plant, has an estimated life of 15 years, whereas the coal burning plant would have 20 years.

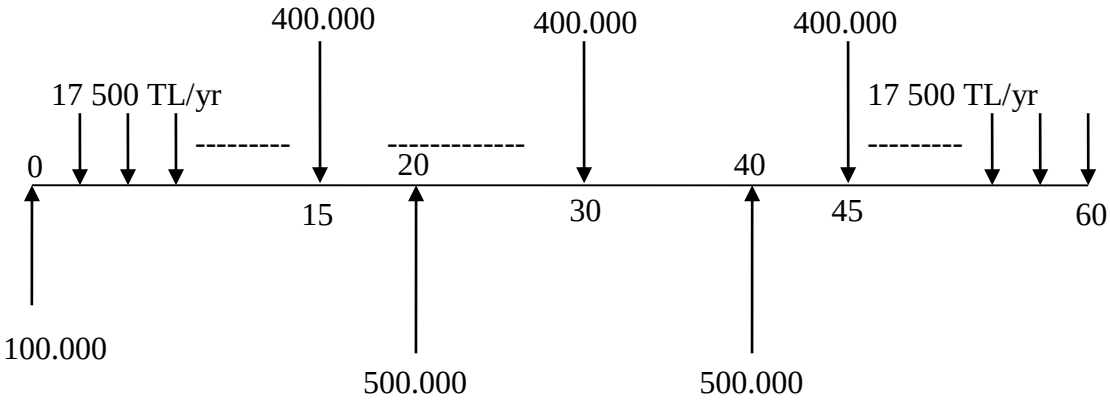
Which type of plant would you recommend if MARR = 6 %. Solve the problem by using rate of return method. Use “Short- cut” method in your solution.





MARR = 6 %
Current Best = Fuel Oil
Challenger = Coal

CH - CB



PW = 0 = - 100.000 – 500.000 (P/F, i*, 20) – 500.000(P/F, i*, 40) + 17500 (P/A, i*,60) + 400.000 (P/F, i*, 15) + 400.000(P/F, i*,30) + 400.000(P/F, i*, 45)

Let i* = MARR
PW = -100.000 – 500.000 (0,3118) – 500.000(0,0972) + 17.500 (16,1614) + 400.000(0,4173) + 400.000(0,1741) + 400.000 (0,0727)

PW = 243.964,5 TL Since result is positive MARR < i*

∴ CB is eliminated, challenger becomes CB. So choose coal burning plant.

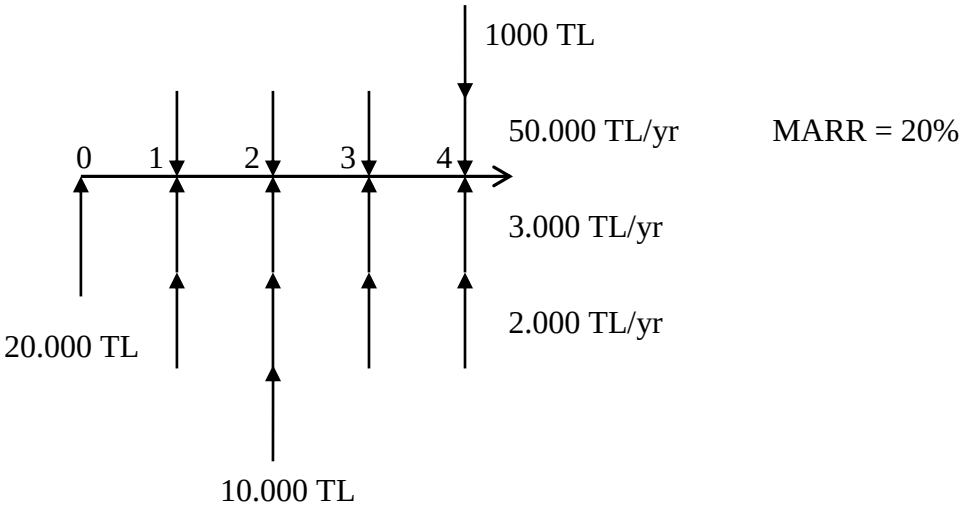
PROBLEM 16

Two alternatives for a bridge construction are tabulated as follows.

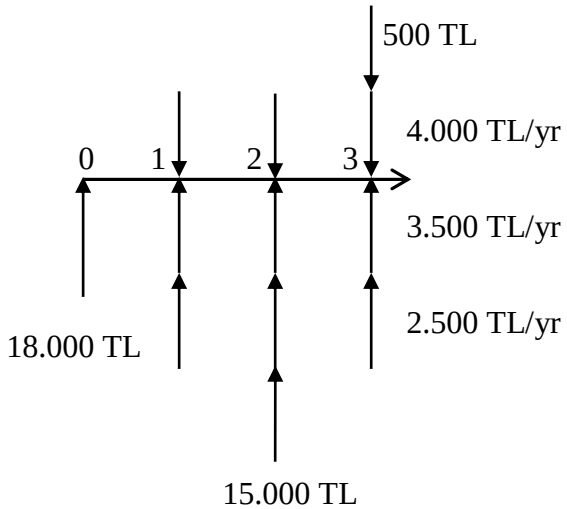
	ALT A	ALT B
Initial payment	20.000 TL	18.000 TL
Annual maintenance costs	3.000 TL/yr	3.500 TL/yr
Annual operation costs	2.000 TL/yr	2.500 TL/yr
Salvage Value	1.000 TL	500 TL
Useful Life	4 yr	3 yr
Annual incomes	50.000 TL/yr	40.000 TL/yr
Extra expenditure at second year	10.000 TL	15.000 TL

If MARR = 20%, Determine the best alternative by using Present Worth Comparison Method.

ALT A



ALT B



AE_A = – 20.000(A/P,20,4) – 3.000 – 2.000 – 10.000 (P/F,20,2)(A/P,20,4) + 50.000 + 1000(A/F,20,4)
AE_A = – 20.000(0.38629) – 3.000 – 2.000 – 10.000 (0,6944)(3,8629) + 50.000 + 1000 (0,18629)
AE_A = – 7.725,8 – 3.000 – 2.000 – (6.944 x 0,38629) + 50.000 +186,29
AE_A = 37.778,09 TL/yr

PW_A = 34.778,09 (P/A,20,12)
PW_A = 34.778,09 x 4,439
PW_A = 154.379,94 TL

AE_B = –18.000 (A/P,20,3) –3.500 – 2.500 – 15.000 (P/F,20,2) (A/P,20,3) + 40.000 + 500(A/F,20,3)
AE_B = – 18.000(0,47473) – 3.500 – 2.500 – 15.000 (0,6944) (0,47473) + 40.000 + 500(0,27473)

AE_B = – 8.545 – 3.500 – 2.500 – 4.945 + 40.000 + 137,4
AE_B = 20.647,37 TL/yr
PW_B = 20.647,37(P/A,20,12)
PW_B = 20,647,37 (4,439)
PW_B = 91.653,65 TL/yr

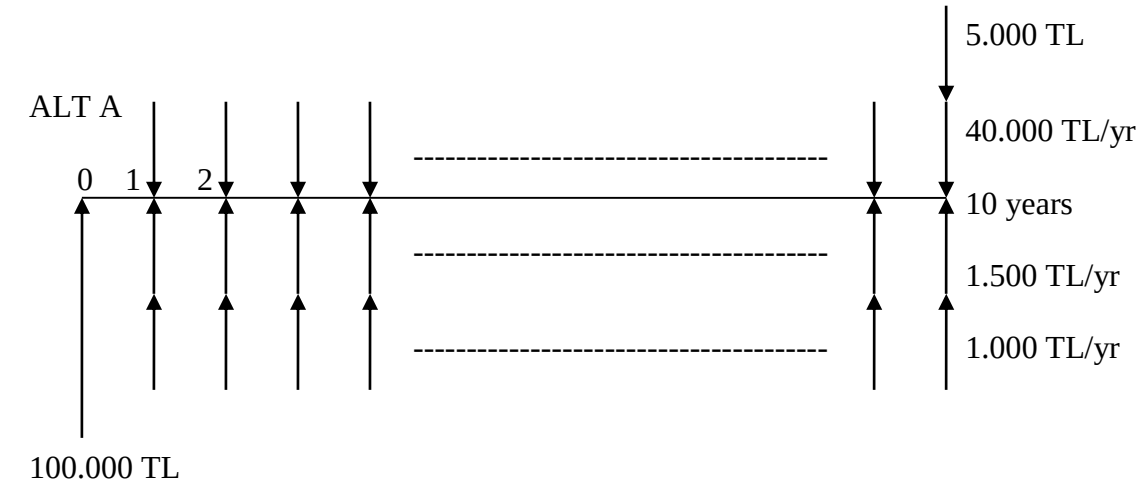
Since $PW_A > PW_B$ choose ALT A

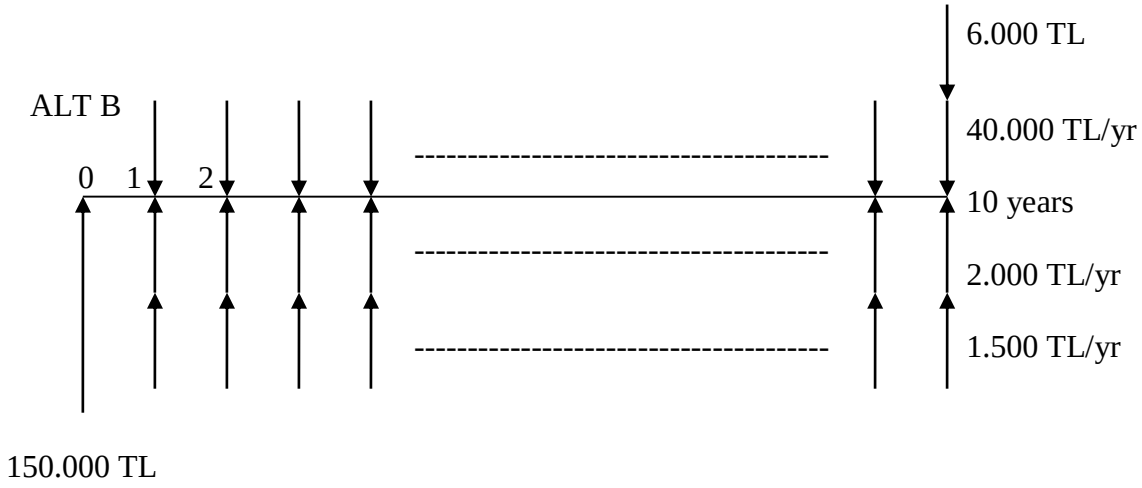
PROBLEM 17

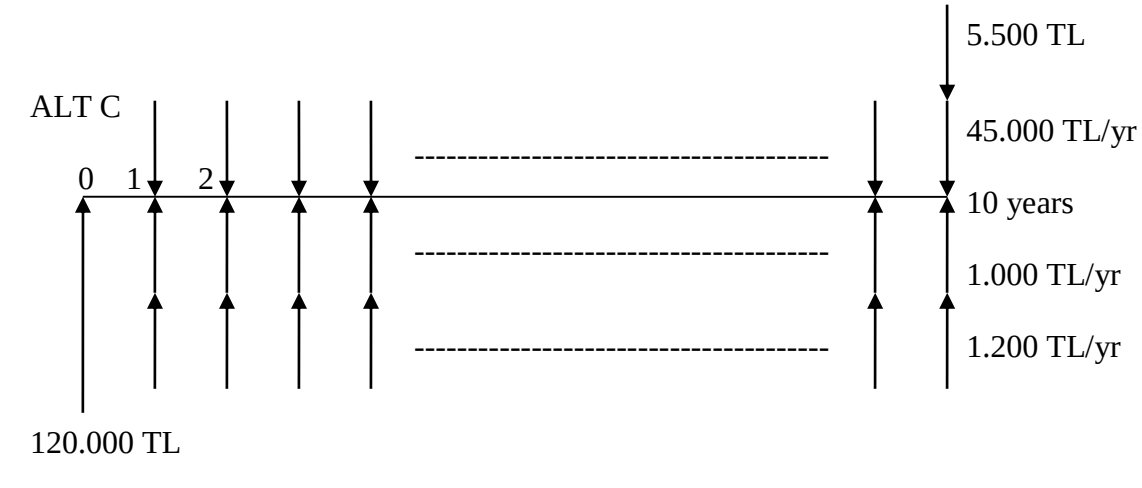
Two cities will be connected to each other by a railroad. There exist three alternatives for the construction.

	ALT A	ALT B	ALT C
Initial Payment	100.000 TL	150.000 TL	120.000 TL
Annual maintenance cost	1.500 TL/yr	2.000 TL/yr	1.000 TL/yr
Annual operational cost	1.000 TL/yr	1.500 TL/yr	1.200 TL/yr
Annual income	40.000 TL/yr	40.000 TL/yr	45.000 TL/yr
Salvage value	5.000 TL	6.000 TL	5.500 TL
Useful life	10 years	10 years	10 years

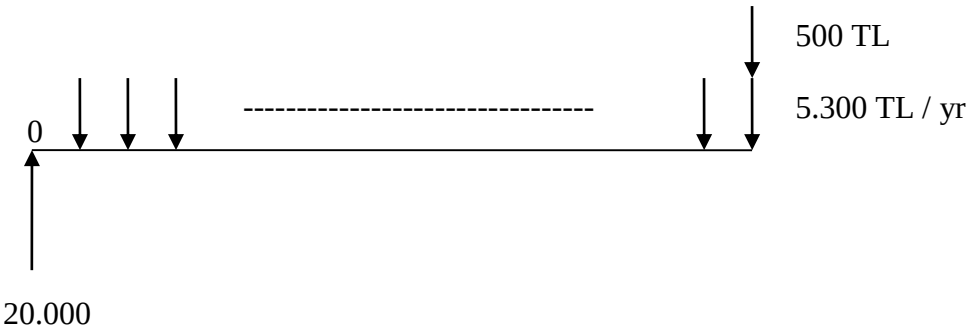
If MARR = 10 % Determine the most desirable alternative by using rate of return method of comparison and annual equivalent values. **You can use Short Cut Method!**







1. Ascending Order A – C – B
2. CB $\rightarrow$ A
   CH $\rightarrow$ C
3. C – A

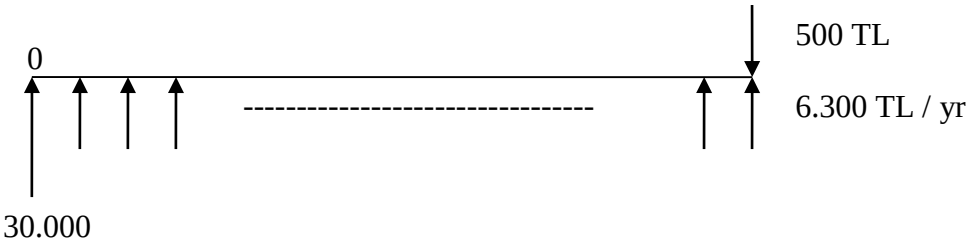


$AE_{C-A} = -20.000(A/P, i^*, 10) + 5.300 + 500(A/F, I^*, 10) = 0$ $i^* = MARR$
$AE_{C-A} = -20.000 \times 0{,}16275 + 5.300 + 500 \times 0{,}06275$
$AE_{C-A} = 2.076{,}58$ TL/yr (Positive Value)

$\therefore$ Current best is eliminated challenger becomes current best

So,

1. CB $\rightarrow$ C
   CH $\rightarrow$ B
2. B – C



$AE_{B-C} = -30.000(A/P, i^*, 10) - 6.300 + 500(A/F, I^*, 10) = 0$ $i^* = MARR$
$AE_{B-C} = -30.000 \times 0{,}16275 - 6.300 + 500 \times 0{,}06275$
$AE_{B-C} = -11.151{,}13$ TL/yr (Negative Value)

$\therefore$ Current best remains current best challenger is eliminated

So, choose ALT C

PROBLEM 18

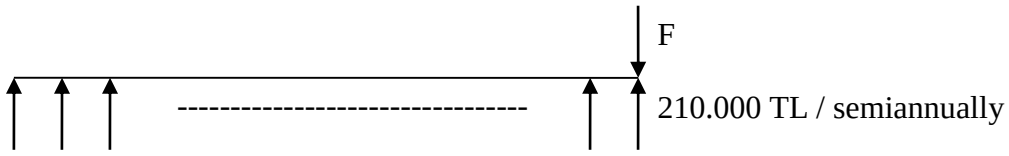
A firm deposits 210.000 TL semiannually in a bank for 5 years with a nominal interest rate of 6,84 % compounded quarterly. At the end of the 5th year they want to construct a building. The following alternatives are being considered:

	Alternative A	Alternative B
Initial cost	1.000.000 TL	1.200.000 TL
Estimated life	10 years	15 years
Annual disbursements	200.000 TL	160.000 TL

The money accumulated in the bank at the end of the 5 year period will be distributed annually during the estimated lives of the alternatives and will be considered as incomes.

Determine which alternative is more desirable by using present-worth comparison.

Effective annual interest rate: $i = \left(1 + \frac{r}{c}\right)^c - 1$



$i_q = \frac{6{,}84}{4} = 1{,}71\%$

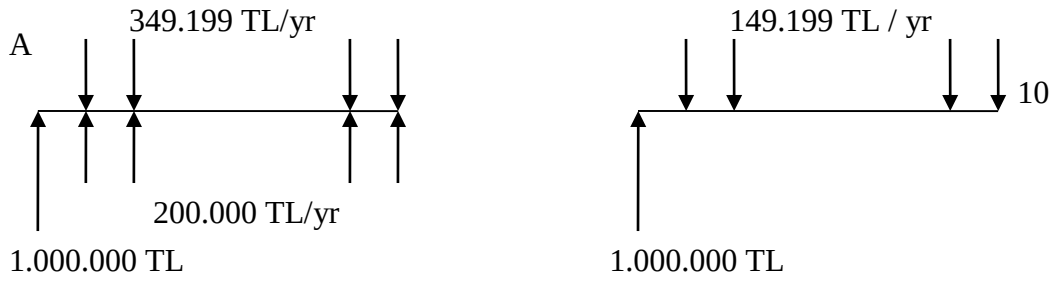
i = (1 + 0,0171)^4 – 1 = 7 %

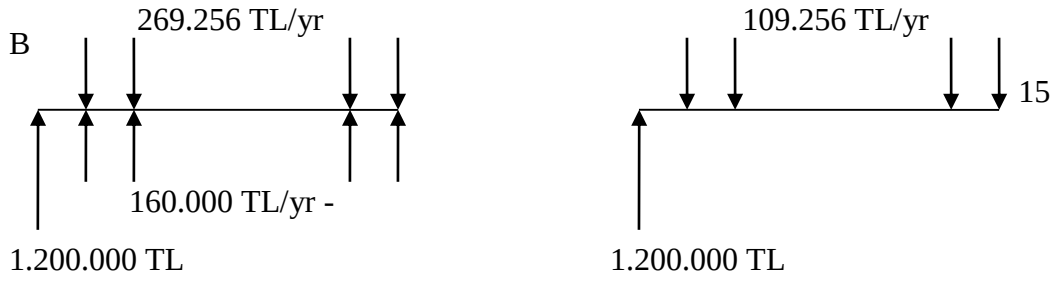
0,07 = (1 + i_s)^2 – 1 $\Rightarrow$ i_s = 3,4 %

$$F = A\left[\frac{(1+i_s)^{10}-1}{i_s}\right] = 2100\left[\frac{(1+0{,}034)^{10}-1}{0{,}034}\right]$$

F = 210.000 x 11,67 = 2.452.237 TL

R_A = 2.452.237 (A/P,7,10) = 2.452.237 x 0,1424 = 349.199 TL/yr
R_B = 2.452.237 (A/P,7,15) = 2.452.237 x 0,1098 = 269.256 TL/yr





$(AE)_A$ = - 1.000.000 (A/P,7,10) + 149.199
= - 1.000.000 x 0.1424 + 149.199
= - 142.400 + 149.199 = 6.799 TL/yr

$(AE)_B$ = - 1.200.000 (A/P,7,15) + 109.256
= - 1.200.000 x 0.1098 + 109.256
= - 131760 + 109.256 = -22.504 TL/yr
$(PW)_A$ = 6799 (P/A, 7 ,30)
= 6799 x 12.4091
= 84.369 TL

$(PW)_B$ = -22.504 (P/A,7 ,30)
= - 22.504 x 12,4091
= - 279.254 TL

Choose Alternative A