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Subject : Financial Mathematics 1
chapter : 5, 6, 7, 8 (Unit 3 and 4)
Assignment 2

Q1 Loan amount = Rs 20,000
c = Rs 427.90 (Monthly arrears)
n = 5 years

i) $APR \approx 2 \times \text{Flat rate}$

$$\approx 2\left(\frac{\text{Total payment} - \text{Orignal Loan}}{\text{Orignal Loan} \times \text{Term in years}}\right)$$

$$\approx 2\left(\frac{427.90 \times 60 - 20{,}000}{20{,}000 \times 5}\right)$$

$$\approx 2\left(\frac{5674}{100000}\right)$$

$$\approx 0.11348$$

$$\approx 11.348\%$$

ii) Term = ?

$APR \approx 0.11348$

$$2\left[\frac{(427.90 \times 12) + (274.49 \times 12n) - 20{,}000}{20{,}000n}\right] = 0.11348$$

$$\frac{5134.8 + 3293.88n - 20000}{20000n} = 0.05674$$

$\Rightarrow 3293.88n - 14865.2 = \frac{2269.6n}{2}$

$\therefore 2159.08n = 14865.2$

$n = 6.885$ years

iii) Total Interest initially = Rs 5674

[Total payment - Orignal loan]

Total Interest reconstructed =

$(427.90 \times 12) + (274.49 \times 12(6.885))$

= Rs 7813.1638

More Interest = 7813.1638 - 5674

= Rs 2139.1638

Q2
i)
a) Discounted Payback Period - The time where the net cash flow changes sign only once, from negative to positive, being unique is referred to as discounted payback period. It is ~~used~~ calculated by discounting future cashflows and recognising time value of money.

b) Payback Period - The time where the ~~net present~~ net negative cashflow is fully repaid ~~o~~ is called payback period without taking into account the time value of money.

ii) Discounted Payback Period and Payback Period with net present value:
The comparison is that discounted payback period takes into account time value of ~~tu~~ money while payback period does not take into account time value of money.
It is superior because it takes into account time value of money.

iii)

Project A		Project B	
- Rs 170,000	Yr 0	- Rs 200,000	Yr 0
- Rs 20,000	Yr 1 End	+ Rs 14,000	Yr 1 to 6 each yr
- Rs 10,000	Yr 2 End	+ Rs 200,000	Yr 6
+ Rs 20,000	Yr 1, Yr 2		
+ Rs 200,000	Yr 3		

a) <u>Project A</u>

Expenses of the project (Present value):

$-170,000 - 20,000v - 10,000v^2$

Income of the project (Present value):

$20,000v + 20,000v^2 + 200,000v^3$

∴ The equation of net present value can be shown as:

$-170,000 - \cancel{20,000v} - 10,000v^2 + \cancel{20,000v}$
$+ 20,000v^2 + 200,000v^3$

$\therefore -170,000 + 10,000v^2 + 200,000v^3$

To find IRR, NPV = 0

$\therefore -170,000 + 10,000v^2 + 200,000v^3 = 0$ — (1)

$-17 + v^2 + 20v^3 = 0$

For v = 0.5	R.H.S = −14.25
For v = 0.9	R.H.S = −1.61
for v = 1	R.H.S 4

For 0.93	R.H.S = −0.047
For 0.94	R.H.S = 0.4952
For 0.931	R.H.S = 5.8×10^{-3}

$\therefore v = 0.931$

$(1+i) = (0.931)^{-1}$

$i_A = 0.0741139 = 7.4\%$

Project B

Expenses of the project (Present Value):
$-200,000$

Income of the project (Present value):
$14000\, a_{\overline{6}|} + 200,000 v^6$

$\therefore$ The equation of net present value can be shown as:

$$-200,000 + 14000\, a_{\overline{6}|} + 200,000 v^6$$

$$= -200,000 + 14000\left(\frac{1-v^n}{i}\right) + 200,000 v^6$$

$$= -200,000 + 14000\,\frac{(1-v^n)}{(v^{-1}-1)} + 200,000 v^6 \quad \text{— ①}$$

To find IRR, NPV = 0

$$\therefore -200,000 + 14000\,\frac{(1-v^6)}{v^{-1}-1} + 200,000 v^6 = 0$$

$$\therefore -200 + 14\left(\frac{1-v^6}{v^{-1}-1}\right) + 200 v^6 = 0 \quad \text{— ②}$$

For $v = 0.5$ R.H.S $= -142.4$
$v = 0.9$ R.H.S $= 1347$
$v = 0.7$ R.H.S $= 158.24$
$v = 0.6$ R.H.S $= -49.34$
$\therefore v = 0.63$ R.H.S $= -2.586$
$v = 0.64$ R.H.S $= 15.593$

$\therefore$ By Trial & Error Method, $v \approx 0.632$

$$(1+i) = (0.632)^{-1}$$

$$i_B = 58.2\%$$

b) NPV at 6%

for $i = 6\%$ $v = 0.943396$

Project A

Using eqn ①,

NPV =

$-17 + v^2 + 20v^3 = \cancel{0}$

$= -17 + (0.943396)^2 + 20(0.943396)^3$

$= 0.682369$

Project B

Using eqn ②

$NPV = -200 + 14\left(\frac{1-v^6}{v^{-1}-1}\right) + 200v^6$

$= -200 + 14\left[\frac{1-(0.943396)^6}{(0.943396)^{-1}-1}\right] +$

$200(0.943396)^6$

$= 9.834390598$

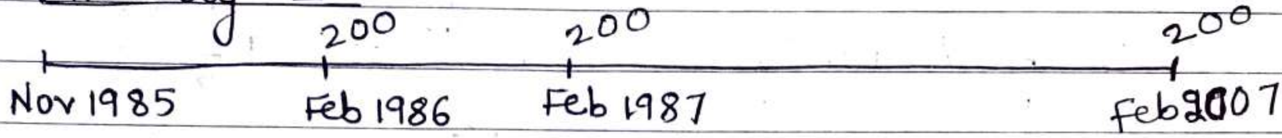
c) Maximum interest rate =

For Project A maximium interest rate is 7.4% because ~~belo~~ above this the return will be negative & project becomes unproductive

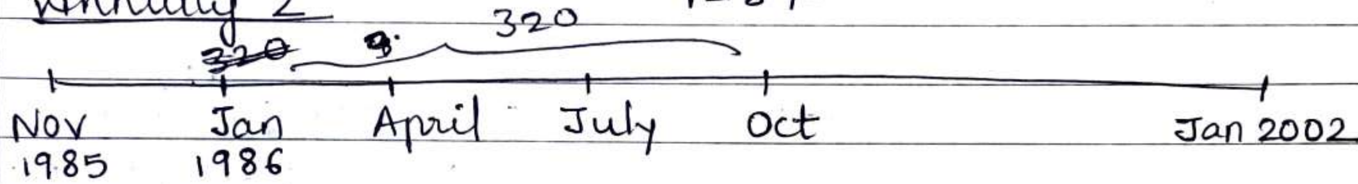
Similarly, for Project B, maximum interest rate is 58.2%

Investor must consider NPV, Index linked, Rate of Returns

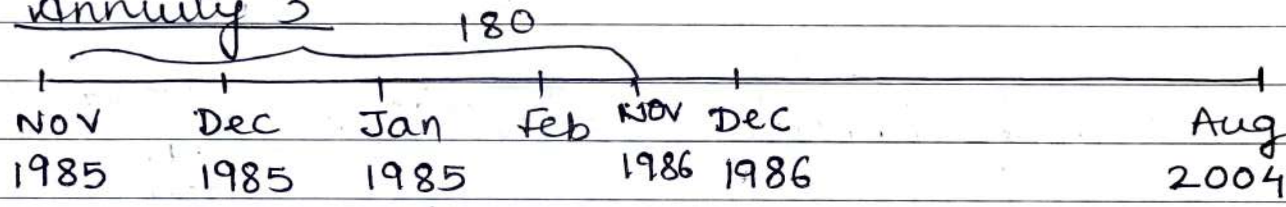
Q3 Annuity 1 $i = 8\%$



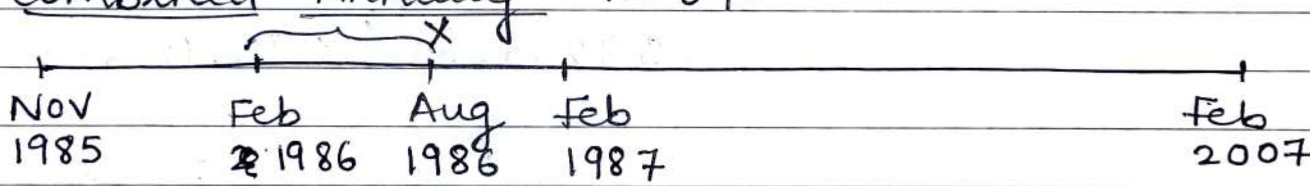
Annuity 2 $i = 8\%$



Annuity 3 $i = 8\%$



Combined Annuity $i = 8\%$



P.V of combined Annuity $= \left(\text{P.V of Annuity 1}\right) + \left(\text{P.V of Annuity 2}\right) + \left(\text{P.V of Annuity 3}\right)$

P.V of Annuity 1 $= v^{3/12} \times a_{\overline{20}|}^{@8\%} \times 200$

$= (0.925926)^{1/4} \times \overset{10.0168}{\cancel{9.8181}} \times 200$

$= 9.63100\,3064 \times 200$

$= 1965.183314$

P.V of Annuity 2 $= v^{2/12} \times a^{(4)@8\%}_{\overline{16}|} \times 320$

$= v^{1/6} \times a_{\overline{16}|} \times \frac{i}{i^{(4)}} \times 320$

$= (0.925926)^{1/6} \times 8.8514 \times 1.029519 \times 320$

$= 2878.894112$

P.V of Annuity 3 $= v^{3/12} \times a^{(12)@8\%}_{\overline{21}|}$ 19.67

$= v^{1/4} \times a_{\overline{21}|} \times \frac{i}{i^{(12)}} \times 180$

$= (0.925926)^{1/4} \times 10.0168 \times 1.036157 \times 180$

$= 1832.614603$

$\therefore$ P.V of combined Annuity $= 1965.183314 + 2878.894112 + 1832.614603$

$= 6544.123318$

Let X be Annual Rate of payment

$\therefore 6544.123318 \ \cancel{a} = X \ a_{\overline{\ }|}$

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P.V of Annuity 3 $= v^{1/12} \times a^{(12)}_{\overline{19.67}} @8\% \times 180$

$= v^{1/12} \times \left(\frac{1 - v^{(19.67)}}{i^{(12)}}\right) \times 180$

$= (0.925926)^{1/12} \times \frac{\left(1 - (0.925926)^{19.67}\right)}{0.077208} \times 180$

$= 1806.683385$

P.V of combined Annuity $= 1965.183314 + 2878.894112 + 1806.683385$

$= 6650.760811$

Let X be Annual Rate of payment

$6650.760811 = X \; a^{(2)}_{\overline{21}} \times v^{3/12}$

$6650.760811 = X \times 10.0168 \times 0.078461 \times 0.925926^{0.25}$

$X = 8626.694485$

$\therefore$ Annual Rate is ₹ 8626.694485

Q5. $(I\ddot{a})_{\overline{n|}}$ for $i > 0$

The notation $(I\ddot{a})_{\overline{n|}}$ is used to denote the present value of an increasing annuity due payable for n time units, the nth payment (of amount n) being made at time n-1.

<u>Present Value</u>

$$(I\ddot{a})_{\overline{n|}} = 1 + 2v + 3v^2 + \dots\dots\dots nv^{n-1} \quad — (1)$$

Multiplying both sides by v

$$v(I\ddot{a})_{\overline{n|}} = v + 2v^2 + 3v^3 \dots\dots + (n-1)v^{n-1} + nv^n \quad — (2)$$

Subtract 1 from 2

$$(I\ddot{a})_{\overline{n|}} \cdot (1-v) = 1 + v + v^2 + v^3 \dots v^{n-1} - nv^n$$

$$= \ddot{a}_{\overline{n|}} - nv^n$$

$$(I\ddot{a})_{\overline{n|}} = \frac{\ddot{a}_{\overline{n|}} - nv^n}{d}$$

~~Q6~~

Q5

i) **Property Fund**

$$(1+i) = \frac{16.4}{12.4}$$

$$= 1.322580645 \quad \therefore TWRR = 32.2581\%$$

Equity Fund

$$(1+i) = \frac{15.5}{12.1}$$

$$= 1.280991736 \quad \therefore TWRR = 28.0992\%$$

ii)

a) Yield = ? He brought same no. of units on each ~~day~~ date say X

$$\text{Yield} = \frac{\cancel{12.4X}}{\cancel{13.1}} \quad \frac{\cancel{13.1}}{\cancel{12.4X}} \times \frac{\cancel{14.8}}{13.1X} \times \frac{15.8}{\cancel{14.8X}} \times \frac{16.4}{\cancel{15.8X}}$$

$$\text{Amount Invested} : X + Xv^{1/4} + Xv^{1/2} + Xv^{3/4}$$

$$\text{Amount earned} : \frac{16.4}{12.4}Xv^{1/4} + \cancel{13.1}\ \frac{16.4}{13.1}Xv^{2/4} + \frac{16.4}{14.8}Xv^{3/4} + \frac{16.4}{15.8}Xv^{[illegible]}$$

Yield = Amount earned − Amount Invested

$$= \left(\frac{16.4}{12.4}X - X\right)v^{1/4} + \left(\frac{16.4}{13.1}X - X\right)v^{1/2} + \left(\frac{16.4}{14.8}X - X\right)v^{3/4}$$

a) Yield $= \frac{16.4}{12.4} + \frac{16.4}{13.1} + \frac{16.4}{14.8} + \cancel{15.8}\ \frac{16.4}{15.8}$

$= 4.720571834$

b) Yield =

Q6 Loan = ₹ 160,000
n = 10 years (arrears)
i = 8%

i) Let Initial Amount of annual payment be given by X.
∴ We can express the loan amount as equivalent to X into annuity factor

$$\therefore 160{,}000 = X \, a_{\overline{10}|}^{@8\%}$$

$$160{,}000 = X\,(6.7101)$$

$$X = 23{,}844.65209$$

∴ Initial Amount of annual payment be 23,844.65209.

ii) Loan Outstanding at 4th year:

$$= X_5 v + X_6 v^2 \ldots X_{10} v^6$$
$$= 23{,}844.65209\,(v + v^2 \ldots v^6)$$
$$= 23{,}844.65209 \; a_{\overline{6}|}^{@8\%}$$

$$= 23{,}844.65209 \times 4.6229$$
$$= 110{,}231.4422$$

Revised Amount be Y

$$\therefore 110{,}231.4422 = Y \, a_{\overline{6}|}^{@10\%}$$

$$110{,}231.4422 = Y \times 4.3553$$
$$\therefore Y = 25{,}309.72428$$

∴ Revised Amount = 25,309.72428

iii) Loan Outstanding after 7^{th} Payment

$$= X_8 v + X_9 v^2 + X_{10} v^3$$

$$= \cancel{1102}\ 25309.72428 \left(v + v^2 + v^3 \right)$$

$$= 25309.72428 \times a_{\overline{3|}}^{@10\%}$$

$$= 25309.72428 \times 2.4869$$

$$= 62{,}942.75331$$

∴ Final amount of level be W & is given by

$$62942.75331 = W \ a_{\overline{3|}}^{@9\%}$$

$$62942.75331 = W \times 2.5313$$

$$W = 24{,}865.78174 \Rightarrow \text{Final amount of level}$$

∴ Actual payments made :

Yr 1	23844.65209
Yr 2	23844.65209
Yr 3	23844.65209
Yr 4	23844.65209
Yr 5	25309.72428
Yr 6	25309.72428
Yr 7	25309.72428
Yr 8	24865.78174
Yr 9	24865.78174
Yr 10	24865.78174

Accumulation of Total payments

$$= 24865.78174\, s_{\overline{3|}}^{@9\%} + 25309.72428\, s_{\overline{3|}}^{@10\%} (1+i)^{3\,@9\%}$$

$$+ 23844.65209\, s_{\overline{4|}}^{@8\%} \times (1+i)^{3\,@10\%} \times (1+i)^{3\,@9\%}$$

$\therefore$ Accumulation of Total Payments

$$= 24865.78174 \times \cancel{3.31} + 3.278 + 25309.72428 \times 3.31 \times \cancel{0.77218}_{(1+i)} + 23844.65209 \times 4.5061 \times 0.7513_{(1+i)} \times 0.77218$$

$$= 81510.03253 +$$

Accumulation of Total Payments

$$= 24865.78174 \times 3.278 + 25309.72428 \times 3.31 \times 1.29503 + 23844.65209 \times 4.5061 \times 1.331 \times 1.29503$$

$$= 81510.03253 + 108491.3809 + 185203.7177$$

$$= 375205.1311$$

effective $i = \dfrac{\text{Accumulation}}{\text{P.V}}$

$$= \frac{375205.1311}{160{,}000}$$

$$= 8.345\%$$

$\therefore$ effective $i = 8.345\%$

Q7. Reasons why investing in property maynot
i) be preferred alternative to investing in Government securities :

1. Property ~~is~~ has less liquidity. Therefore ~~the~~ to sell the property and divest money, it takes time. So, instant withdrawl of money from property for emergency is not possible.
2. Property over the years has shown zero or negative returns when inflation being taken into account. However, the government securities ~~give~~ ~~pos~~ covers inflation losses atleast if not positive returns over years taking inflation into account.
3. Government securities are less risky as compared to property.

ii)
a) It refers to the process in which the government offers loans to individuals or institutions by bids. The bids of ~~the~~ individuals or institutions that enable the government to get ~~largest~~ lowest interest over the loans bonds are selected. This is usage of tendering in loans.

b) Advantages to investors of issuing bonds at a set price is low administrative costs and time. Disadvantage is that they donot get volatity / chance for lower interest payments.

c) Securities having uncertain returns:

1) Equity securities : Market prices are very ~~2)~~ volatile and sensitive to company performance, sector performance & market news.

2) Insurance : Time of happening of event insured against is uncertain which makes the returns uncertain.

3) Bonds: It depends on the LIBOR.

Q8. Expenses of company

-2.7 Cr

-0.2 Cr arrears Yr 1 to 3.

Income of company

$+0.1$ Cr

$X =$ no. of strikes

$P(X=1) = 0.25$

$P(X=2) = 0.2$

$P(X=3) = 0.1$

1 strike $\Rightarrow$ 50,000 barrels

$\Downarrow$

for 10 yrs from end of year of strike

Barrel	50,000	100,000	150,000
$P(X=x)$	0.25	0.2	0.1
Amount	200	200	200

i) P.V of outlays $= -2.7\,Cr - 0.2\, a_{\overline{3}|}^{@i\%}\, Cr$

$$= -2.7\,Cr - 0.2 \times \frac{1-v^n}{v^{-1}-1}\, Cr.$$

$$= -2{,}70{,}00{,}000 - 20{,}00{,}000\,\frac{1-v^n}{v^{-1}-1}$$

P.V expected income

$= ~~50{,}000 \times 0.25 \times 200 + 100{,}000 \times 0.25 \times~~$

$= 50{,}000 \times 0.25 \times 200 \times \bar{a}_{\overline{2}|} + 100{,}000 \times 0.2 \times 200 \times \bar{a}_{\overline{2}|} + 150{,}000 \times 0.1 \times 200 \times \bar{a}_{\overline{1}|} + 10{,}00{,}000\, v^3$

$~~+ 50{,}000 \times 0.25~~$

$= 25{,}00{,}000\, \bar{a}_{\overline{2}|} + 40{,}00{,}000\, \bar{a}_{\overline{1}|} + 10{,}00{,}000\, v^3$

$\therefore$ To find interest rate when:

P.V of outlays = P.V of expected income

$$-2{,}70{,}00{,}000 - 20{,}00{,}000 \frac{1-v^3}{v^{-1}-1} = 25{,}00{,}000 \frac{1-v^2}{-\ln v} + 40{,}00{,}000 \frac{1-v}{-\ln v} + 10{,}00{,}000\, v^3$$

$$-27 - 2\left(\frac{1-v^3}{v^{-1}-1}\right) + 25\cancel{,00,000}\left(\frac{1-v^2}{\ln v}\right) + 40\left(\frac{1-v}{\ln v}\right) - 10 v^3 = 0$$

By Trial and error,

$v =$

Q9

i) TWRR : 1/1/2011 to 31/12/2013 (3 years)

$$(1+i)^3 = \frac{33}{30.5} \times \frac{38.5}{33+6} \times \cancel{\frac{45.6}{38.5}} \times \cancel{\frac{45.6}{45.6+4.5}}47$$

$$\times \frac{41.05}{38.5} \times \frac{45.6}{41.05+4.5} \times \frac{\cancel{45.6}\,47}{45.6-2.5}$$

$$= \frac{33}{30.5} \times \frac{38.5}{39} \times \frac{41.05}{38.5} \times \frac{45.6}{45.55} \times \frac{47}{43.1}$$

$$= 1.243253539$$

$$(1+i) = 1.075275873$$
$$i = 7.5275873\%$$

So Annual effective TWRR is 7.5275873%

MWRR : 1/1/2011 to 31/12/2013 (3 yr)

$$\cancel{30.5}\,47v^3 + 6v^{10/12} + 4.5v^{1.5} - 2.5v^{2.5} = \cancel{(1+i)^3}\,30.5$$

By Trial & Error Method,

$v = 0.5$ R.H.S = −20.1

$v = 1$ R.H.S = 24.5

$v = 0.7$ R.H.S = −8.311

$v = 0.8$ R.H.S = 0.3347

$v = 0.79$ R.H.S = −0.624

$\therefore$ By Linear Interpolation

$x_1 = 0.79 \qquad f(x_1) = -0.624$
$x_2 = 0.8 \qquad f(x_2) = 0.3347$
$x = \qquad f(x) = 0$

$$\frac{x - x_1}{x_2 - x_1} = \frac{f(x) - f(x_1)}{f(x_2) - f(x_1)}$$

$$\frac{x - 0.79}{0.8 - 0.79} = \frac{0 + 0.624}{0.3347 + 0.624}$$

$$x = \left(\frac{0.624 \times 0.01}{0.9587}\right) + 0.79$$

$$\therefore v = 0.796508814$$

$$\cancel{v \Rightarrow} \; i = v^{-1} - 1$$

$MWRR = 25.54788\%$ $\therefore$ ~~MWRR~~

ii) $$LIRR = \frac{33}{30.5} \times \frac{38.5}{33} \times \frac{41.05}{38} \times \frac{45}{41.05}$$

$$\times \frac{45.6}{45} \times \frac{47}{45.6}$$

$$\therefore (1+i) = 1.561259$$
$$i = 56.1259\%$$
$$\therefore LIRR = 56.1259\%$$

iii) TWRR considers time value of money and is not sensitive to amount of or quantity of ~~is~~ cashflows involved.

Q10. ~~8~~ Given :
i) 80% cost of House from bank
Loan : Increasing Annuity
It is arrears, in 15 years
first repayment : Rs 2,00,000
increase factor : Rs 20,000
$i = 12\%$.

Loan Amount = P.V of the Increasing Annuity

$$\text{P.V of Increasing Annuity} = ₹\,180000\, a_{\overline{15}|}^{@12\%} + 20{,}000\,(Ia)_{\overline{15}|}^{@12\%}$$

$$= 180000 \times 6.8109 + 20{,}000 \times 40.731$$
$$= 20{,}40{,}582$$

$\therefore$ 80% of Total = Loan
80% of Total = 2040582

$$\text{Total} = \frac{2040582}{0.08}$$
$$= ₹\,2{,}55{,}07{,}275$$

ii) Yr 9, Yr 10

Loan Outstanding at 8th Yr;
8th Payment : Rs 3,40,000

$$\therefore \quad L = 3,20,000\, a_{\overline{3}|}^{@12\%} + 20,000\, Ia_{\overline{3}|}^{@12\%}$$

$$= 3,20,000 \times 2.4018 + 20,000 \times 4.6226$$

$$= 861028$$

Yr	Loan	Installment	Interest	Capital Repaid	Capital Outstanding
9	860128	3,60,000	103323.36	256676.64	603451.36
	603451.36	3,80,000	72414	603451	0

Q11.
i) TWRR is given as 20%

$$\frac{500}{460} \times \frac{\cancel{550}}{500+40-50} \times \frac{\cancel{600}}{\cancel{550}} \times \frac{X}{\cancel{600}} = (1+i)^2$$

$$\frac{500}{460} \times \frac{X}{490} = 1.2^2$$

$$X = 649.152$$

Q12.

ii) MWRR :

$$649.152v^2 + 40\,v^{3/12} - 50v = 460$$

By Trial & Error

$V = 0.8$ $\quad$ R.H.S $= -46.71$

$V = 0.9$ $\quad$ R.H.S $= 59.773$

$V = 0.84$ $\quad$ R.H.S $= -5.664$

$V = 0.85$ $\quad$ R.H.S $= 4.9197$

$x_1 = 0.845$ $\quad$ $f(x_1) = -0.388$

$x_2 = 0.846$ $\quad$ $f(x_2) = 0.6705$

$x = ?$ $\quad$ $f(x) = 0$

$$\frac{x - x_1}{x_2 - x_1} = \frac{f(x) - f(x_1)}{f(x_2) - f(x_1)}$$

$$x = \left[\frac{0 + 0.388}{0.6705 + 0.388} \times 0.001\right] + 0.845$$

$$= 0.845366564$$

iii) LIRR $\Rightarrow \frac{500}{460} \times \frac{550}{500} \times \frac{600}{550} \times \frac{649.152}{600}$

$(1+i) = 1.4112$

$i = 41.12\%$

iv) It will be same as TWRR when there will be no cash flow.

v) TWRR is better because it considers time value of money & is not affected by amount of money.

Q12. <u>Cashflows given</u>:

$-800{,}000$	$t=0$
$-\ 50{,}000$	$t=1$
$+\ 10{,}000$	20yrs ($t=2$ to $t=22$) "continuously"

i) Discounted Payback Period – The time where the net cash flow changes ~~sing~~ sign only once from negative to positive, being unique is referred to as discounted payback period. It is calculated by discounting future cashflows & recognising time value of money.

ii)

a) $i = 7\%$

$$\text{Outflow} = -800{,}000 - 50{,}000v$$
$$= -800{,}000 - 50{,}000(0.934579)$$
$$= -846728.95$$

$$\text{Inflow} = 10{,}000\ \bar{a}_{\overline{20}|}^{@7\%}$$

$$= 10{,}000 \times a_{\overline{20}|}^{@7\%} \times \frac{i}{\delta} \times v^2$$

Let t be the time when inflow = outflow

$$846728.95 = 10{,}000 \times a_{\overline{t}|}^{@7\%} \times 1.0348605$$

$$a_{\overline{t}|}^{@7\%} = \frac{81.84079431}{0.87344} \Rightarrow 93.699$$

FOR EDUCATIONAL USE $\therefore$ since $a_{\overline{t}|}$ is too large.

b) $A.V = -800,000 - 50,000(0.943396)$
$=$

$A.V = -800,000 \times 1.06^{22} - 50,000 \times 1.06^{21}$
(Outflow) $= -3052808.113$

(inflow) $= 10,000\ \bar{a}_{\overline{20|}}$ @6%

$= 10,000 \times 11.4699 \times \frac{i}{\delta}$

$= 10,000 \times 11.4699 \times 1.029709$
$= 118106.5926$

$\therefore$ Accumulation $= -A.V$ outflow $+$ A.V inflow

$= -2934701.52$

Q13. Loan $= 988000$ [10th July, 2015]
Repayable by level annuity monthy arrears.
$n = 25$ yrs $\quad i = 7\%$

i) Let level monthly payment be X

$\therefore 988000 = 12X\ a^{(12)}_{\overline{25|}}$ @7%

$X = \frac{988000}{12 \times \cancel{12.7834} \times} \times \frac{1}{11.6536} \times \frac{1}{1.031691}$

$= 6848.034653$

ii) Loan outstanding at 13.~~6667~~ 8 months yrs &

$L =$ Annuity for 11.3years.

$$= 6848.034653 \times a^{(12)\,@\,7\%}_{\overline{11.3}|}$$

$$= 6848.034653 \times \frac{1 - \left(\frac{1}{1.07}\right)^{11.3}}{0.06785}$$

$$= 53941.84644$$

iii) Repaid on 10th oct 2026 : After 11.~~8~~ 1667 yrs.

$$L_1 = 6848.034653 \times a^{(12)\,@\,7\%}_{\overline{\cancel{13.8667}\ 13.833}|}$$

$$= 6848.034653 \times \frac{1 - \left(\frac{1}{1.07}\right)^{\cancel{11.8}\ 13.833}}{0.06785}$$

$$= 61343.04181$$

iv) ~~Re~~ $L_2 = 6848.034653 \times a^{(12)\,@\,7\%}_{\overline{13.75}|}$

$$= 6848.034653 \times \left(\frac{1 - \left(\frac{1}{1.07}\right)^{13.75}}{0.06785}\right)$$

$$= 100929.0295 \times 0.605567169$$

$$= 61119.30665$$

Repay $= L_1 - L_2$

$$= 61343.04181 - 61119.30665$$

$$= 223.7351578$$