

∴ Original loan amount = £20,000

original
or 2x flat rate.

$$20000 = 12 \times 427.90 a_{\overline{5}|}^{(12)} \Rightarrow a_{\overline{5}|}^{(12)} = 3.8499$$

$$\text{Flat rate} = \frac{\text{total interest}}{\text{loan} \times \text{total years}} = \frac{(5 \times 12 \times 427.90 - 20000)}{20000 \times 5} = 5.67\%$$

$$\text{APR} \approx 2 \times 5.67 \approx 11\%$$

or by calculator

$$i = 11\%, a_{\overline{5}|}^{(12)} = 3.87872$$

$$i = 10\%, a_{\overline{5}|}^{(12)} = 3.96154$$

interpolating APR, i b/w 10% & 11%

$$3.8499 - 3.96154 = 3.87872 - 3.96154$$

$$i = 10.8\%$$

$$\text{At } 10.8\%, 12 \times 427.90 a_{\overline{5}|}^{(12)} = 20000.2$$

$$\text{At } 10.9\%, 12 \times 427.90 a_{\overline{5}|}^{(12)} = 19958.2$$

$i = 10.89\%$ more close. Hence APR is 10.8%

i) APR = 10.8%

$$\text{After 1 year, capital left to pay} = 12 \times a_{\overline{4}|}^{(12)} @ 10.8\% \times 427.90 = 16775.98$$

let t denote the term of new loan then

$$16775.98 = 12 \times 274.49 a_{\overline{t}|}^{(6)}$$

$$16775.98 = 3293.88 (1 - 1.108^{-t})$$

$$12 \times (1.108^{1/2} - 1)$$

$$1.108^{-t} = 0.4754$$

$$t = 7.25 \text{ years}$$

ii) The original loan had 4 years of payments remaining thus,

$$\text{Total Interest} = 4 \times 12 \times 627.90 = 16775.68$$

$$= 3763.22$$

New loan has a term of 7.25 years hence

$$\text{Total Interest} = 7.25 \times 12 \times 274.69 = 16775.68$$

$$= 7104.65$$

They will have to pay $(7104.65 - 3763.22) 3341.23$ more interest under

Q2-i) a) Discounted payback period: The discounted payback period is the time t for which the present (or accumulated) value of the up to time t exceeds the present (or accumulated) value of the cost up to time t .

b) Payback period: The payback period is the same as the discounted payback period, except the present value calculation is carried out using an interest rate of 0. In other words, it is the time for which the monetary value of the return exceeds the monetary value of the cost.

ii) Unlike the NPV, neither the DPP nor the PP give an indication how profitable a project is, as they ignore cash flows after the accumulated value zero is reached.

There may not be one unique time when the balance in the investor's account changes from negative to positive. However, it can always be calculated.

The PP can give misleading results, as it does not take into account the time value of money.

Hence NPV is a superior measure of investment decision.

a) Internal rate of return

The IRR for Project A is the rate of interest that satisfies the equation of value.

$$-170000 - 20000v + 10000v^2 + 20000v^3 + 20000v^4 + 200000v^5 = 0$$

$$10v^2 + 200v^3 = 170$$

$$10v^2 + 200v^3 - 170 = 0$$

$$0.9 \rightarrow -16.1$$

$$1 \rightarrow 40$$

$$0.93 \rightarrow -0.479$$

$$0.94 \rightarrow 4.9538$$

$$0.9309 \rightarrow 0.0046$$

$$i = 0.9309$$

$$\frac{1}{1+i} = 0.9309$$

$$i = 0.07422924052$$

$$i = 7.42292\% = 7.4\%$$

So IRR for Project B is exactly ~~7.4%~~ 7.4%.

b) Net Present Value.

$$140000 + 20000v = 200000$$

The net present value are found by discounting the payments at 6%.

$$\text{Project A NPV} = -170000 + 10000v^2 + 200000v^5 = 683.82$$

$$\text{Project B NPV} = -200000 + 140000v + 200000v^6 = 9834.645$$

c) Maximum Interest Rate beyond which projects are unprofitable

Each project will be profitable if the rate of interest at which funds can be borrowed is less than the internal rate of return. So to be profitable, Project A requires a borrowing rate less than 7.42292% and Project B requires a rate lower than 7%.

Other factors to be considered include:

- Project A does not provide any net income during the first year.
- The lower internal rate of return for Project B applies for a longer period.

- Rate of interest available in year 5 will affect the comparison between the accounting profit at the end of year 6.
- The risk associated with the receipt of income. If Project has greater uncertainty or risk, it may not be accepted even if it has a higher IRR.

3) Value of 1st November 1985 is

$$\text{Annuity 1} = 200 \times v^{(1/4)} \times a_{\overline{22}|} \text{ at } 8\%$$

$$= 200 \times v^{1/4} \times a_{\overline{22}|} \times \frac{i}{d}$$

$$v^{1/4} = 0.980944$$

$$10.2007$$

$$a_{\overline{22}|} = 10.6748$$

$$d = 0.074074$$

$$= 200 \times 0.980944 \times 10.6748 \times \frac{0.08}{0.074074}$$

$$= 2161.366301$$

$$\text{Annuity 2} = 320 (1+i)^{1/12} \times a_{\overline{16}|} \text{ at } 8\%$$

$$(1+i)^{1/12} = 1.006434$$

$$= 320 \times 1.006434 \times 1 - (0.925926)^{16.25}$$

$$0.0877706 \quad i(16.25) = 0.077706$$

$$= 320 \times 1.006434 \times 9.184257$$

$$= 2957.870081$$

$$\text{Annuity 3} = 180 \times a_{\overline{18.75}|} \text{ at } 8\%$$

$$i(18.75) = 0.0777208$$

$$= 180 \times 1 - (0.925926)^{18.75}$$

$$v = 0.925926$$

$$0.0777208$$

$$= 180 \times 9.892578702$$

$$= 1780.664166$$

Let the revised annuity be A

$$\text{Value of revised annuity is } A \times (1+i)^{1/4} \times a_{\overline{21.5}|} \text{ at } 8\%$$

$$A = 6889.90$$

$$1.019427 \times 10.30886$$

$$= 656.56$$

4) $(I\ddot{a})_n$ for $i > 0$

$$\begin{array}{ccccccc} 1 & 2 & 3 & 4 & \dots & n \\ \hline 0 & 1 & 2 & 3 & \dots & n-1 \end{array}$$

$$(I\ddot{a})_n = 1 + 2v + 3v^2 + 4v^3 + \dots + nv^{n-1} \quad \text{--- (1)}$$

$$(I\ddot{a})_n = (1+i)(Ia)_n$$

$$= (1+i) \frac{\ddot{a}_n - nv^n}{i}$$

$$= \frac{\ddot{a}_n - nv^n}{i}$$

$$1+i$$

$$I\ddot{a}_n = \frac{\ddot{a}_n - nv^n}{d}$$

OR

Multiplying both sides by v

$$v(I\ddot{a})_n = v + 2v^2 + 3v^3 + 4v^4 + \dots + nv^n \quad \text{--- (2)}$$

Subtracting

$$(1-v)(I\ddot{a})_n = (1 + v + v^2 + v^3 + v^4 + \dots + v^{n-1}) - nv^n$$

$$(1-v)(I\ddot{a})_n = \frac{1-v^n}{1-v} - nv^n$$

$$d(I\ddot{a})_n = \ddot{a}_n - nv^n$$

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

5) Time-weighted rate of return for each fund for the year 2014

Property Fund

$$\frac{16.4 - 1}{12.04} = 0.3226 \text{ or } 32.26\%$$

Equity Fund

$$\frac{15.5 - 1}{12.01} = 0.2810 \text{ or } 28.10\%$$

ii)

a) Assuming that the investor bought 100 units per quarter in property fund the equation of value is given by

$$1240(1+i) + 1310(1+i)^{3/4} + 1480(1+i)^{1/2} + 1580(1+i)^{1/4} = 4 \times 1640$$

$$\text{Let } 1+i = x$$

$$1240x + 1310x^{3/4} + 1480x^{1/2} + 1580x^{1/4} - 6560 = 0$$

$$1240x + 131x^{3/4} + 148x^{1/2} + 158x^{1/4} - 656 = 0$$

$$1 \rightarrow -95$$

$$1.2 \rightarrow -29.51$$

$$1.3 \rightarrow 2.145$$

$$1.29 \rightarrow -0.991$$

$$1.3 \rightarrow 2.145$$

$$1.293 \rightarrow -0.049$$

$$1.297 \rightarrow 0.2638$$

$$1.2931 \rightarrow -0.04$$

$$1.2932 \rightarrow 0.0126$$

$$r \approx 1.2932$$

$$1.8 \approx 1.2932$$

$$I \approx 29.32\%$$

b) Assuming that the investor purchases INR 100 worth of unit

$$\text{quoted } 100 \times \ddot{S}_1^{(u)} = 100 \times 16.4 \left(\frac{1}{12.4} + \frac{1}{13.1} + \frac{1}{14.8} + \frac{1}{15.3} \right)$$

$$\ddot{S}_1^{(u)} = 100 \times 4.72051724$$

472

$$\ddot{S}_1^{(u)} = 1.801$$

$$iii) 1210(1+i)^0 + 920(1+i)^{3/4} + 1030(1+i)^{1/2} + 1310(1+i)^{1/4} = 421550$$

$$\text{Let } 1+i = x$$

$$1210x + 920x^{3/4} + 1030x^{1/2} + 1310x^{1/4} - 6200 = 0$$

$$121x + 92x^{3/4} + 103x^{1/2} + 131x^{1/4} - 620 = 0$$

$$x \rightarrow 1.6 \rightarrow -17.89$$

$$x \rightarrow 1.673 \rightarrow -0.021$$

$$x \rightarrow 1.7 \rightarrow 6.5487$$

$$x \rightarrow 1.674 \rightarrow 6.2224$$

$$x \rightarrow 1.67 \rightarrow -0.752$$

$$x \rightarrow 1.6731 \rightarrow 0.003042268957$$

$$x \rightarrow 1.68 \rightarrow 1.6841$$

$$\therefore x = 1.6731$$

$$1+i = 1.6731$$

$$i = 0.6731 = \underline{67.31\%}$$

$$b) 400 \times \ddot{s}_{\overline{4}|i} = 100 \times 15.5 \left(\frac{1}{12.1} + \frac{1}{9.2} + \frac{1}{10.3} + \frac{1}{13.1} \right)$$

$$\ddot{s}_{\overline{4}|i} = \frac{15.5}{4} (0.0824446281 + 0.1086956522 + 0.09708737864 + 0.0763583786)$$

$$\ddot{s}_{\overline{4}|i} = \frac{15.5}{4} (0.3647635368)$$

$$\ddot{s}_{\overline{4}|i} = 1.413458705$$

$$\frac{(1+i)^4 - 1}{i} = 1.413458705 \quad \therefore d^{(4)} = P \left[1 - \left(\frac{1}{1+i} \right)^{1/r} \right]$$

$$\frac{(1+i)^4 - 1}{4 \left[1 - \left(\frac{1}{1+i} \right)^{1/4} \right]} = 1.413458705 = 0$$

$$\text{Let } 1+i = x$$

$$x - 1 = 1.413458705 = 0$$

$$4 \left(1 - \left(\frac{1}{x} \right)^{1/4} \right)$$

$$1.7 \rightarrow -0.00496$$

$$1.71 \rightarrow 0.000055$$

$$1.7089 \rightarrow 0.00005134432$$

$$1.8 \rightarrow 0.0498$$

$$1.708 \rightarrow -0.00005$$

$$\therefore 1+i = 1.7089$$

$$1.70709 \rightarrow 0.0000035$$

$$i = 0.7089 \text{ or } 70.89\%$$

i) Let x be the initial annual repayment

$$160000 = x a_{\overline{10}|} @ 8\%$$

$$x = \frac{160000}{a_{\overline{10}|}} = \frac{160000}{6.7101} @ 23,844.65.$$

ii) The loan outstanding immediately after 4th payment is

$$23844.65 a_{\overline{7}|} @ 8\% = 23844.65 \times 4.6229 = 110,231.442$$

Let y be the revised annual instalment. The equation of value

$$y a_{\overline{7}|} = 110,231.442 @ 10\%$$

$$y = \frac{110231.442}{a_{\overline{7}|}} = \frac{110231.442}{4.3553} = 25309.72$$

iii) The loan outstanding immediately after 7th payment is

$$25309.72 a_{\overline{3}|} @ 10\%$$

$$= 25309.72 \times 2.4869 = 62942.74$$

Let z be the revised annual instalment

$$z a_{\overline{3}|} = 62942.74 @ 9\%$$

$$z = \frac{62942.74}{a_{\overline{3}|}} = \frac{62942.74}{2.6313} = 24865.77$$

They can be found as

$$160000 + 1465.07 a_{\overline{10}|} = 443.95 x a_{\overline{10}|} - 24865.77 a_{\overline{10}|} @ 0$$

$$160,000 + 1465.07 \left(\frac{1-v^{10}}{i} \right) = 443.95 \left(\frac{1-v^{10}}{i} \right) - 24865.77 \left(\frac{1-v^{10}}{i} \right)$$

$$160,000 + 1465.07 \left(\frac{1 - (1/1.09)^{10}}{0.09} \right) = 443.95 \left(\frac{1 - (1/1.09)^{10}}{0.09} \right) - 24865.77 \left(\frac{1 - (1/1.09)^{10}}{0.09} \right)$$

Investing in property may not be preferred alternative to investing in government securities.

The return on property is lower than that in government security.

It is difficult to invest in property.

Less flexible because of the large unit size.

The market ability for property is poor.

Large buying and selling expenses.

Tender usually refers to process whereby government and financial institutions invite bids for large projects that must be submitted within a short deadline. Government may raise

money by floating a loan or stock exchange. The term of the issue are set out by tender. The investors are invited to nominate the price and it is issued to the highest bidder.

Advantages :- for government :- They will know the price that the investor will pay at outset so it will know the cost of borrowing money.

for Investors :- It will be administratively less difficult by tender.

Disadvantages :-

Investor may be willing to pay more for the bond than the set price and so the money could be borrowed more cheaply if the tender is used.

Insufficient Investor may be prepared to pay the set price causing only part of the offer to be sold and government may not meet its financial requirement.

The securities with uncertain returns are as follows :-

Equity :- the dividend depends on the company's performance.

Property :- Many Rent payments may be subject to review.

Index-linked bonds :- coupon payment and final redemption price may increase in proportion to increase in relevant index of inflation.

e) The present value of outlay is

$$2.7 + 0.2a_3 @ i$$

The expected present value of the income is:

$$1.03v^3 + a_{10} (0.25v + 0.2v^2 + 0.1v^3) @ i$$

Equating the present value of the outlay to the present value of the income

$$2.7 + 0.2a_3 = 1.03v^3 + a_{10} (0.25v + 0.2v^2 + 0.1v^3) @ i$$

ii) Based on the information present value of company's income is

$$0.1v^3 + 0.85a_{10}v^3$$

$$0.1v^3 + 0.85a_{10} - 2.7 - 0.2a_3 @ i = 10\%$$

$$= 0.1 \times 0.7513 + 0.85 \times 0.7513 \times 6.4469 - 2.70 - 0.2 \times 2.4869$$

$$= 4.19 - 3.19$$

$$= 1.0089$$

Since NPV is positive it is worth to invest in the project.

3) TWR

$$(1+i)^3 = \frac{33}{30.50} \times \frac{41.05}{33+6} - 4.5 \times \frac{45.6}{41.05} \times \frac{47}{45.6-2.50}$$

$$(1+i)^3 = 1.08196713 \times 0.9371794872 \times 1.110840438 \times 1.090489$$

$$(1+i)^3 = 1.2281327$$

$$(1+i) = 1.070951281$$

$$i = 0.070951281$$

$$\text{TWR} = 7.0951281\%$$

MWR

$$30.5(1+i)^3 + 6(1+i)^{2.25} + 4.5(1+i)^{1.5} - 2.5(1+i)^{0.5} - 47$$

$$\text{Let } 1+i = x$$

$$30.5x^3 + 6x^{2.25} + 4.5x^{1.5} - 2.5x^{0.5} - 47 = 0$$

$$1 \rightarrow -9$$

$$1.1 \rightarrow 2.9346$$

$$1.07 \rightarrow -0.867$$

$$1.08 \rightarrow 0.3782$$

$$1.076 \rightarrow -0.122$$

$$1.077 \rightarrow 12.00238507$$

- ② TWRF is calculated using "growth factor" reflecting the change in fund value between the time of consecutive cash flows. Thus TWRF is independent of amount and timing of cash flows.
- ③ Hence TWRF is better measure of fund manager's performance.

12) i) The discounted payback period of an investment ^{Project} period is the first time when the net present value of the cash flow from the project is positive.

ii) Let us work in units of 1000

$$-800(1+i)^t - 50(1+i)^{t-1} + 100 \overline{S_{t-2}} @ 7\% = 0$$

$$\text{Net } -800(1+i)^t - 50(1+i)^{t-1} + 100 \times (1+i)^{t-2} - 1 = 0$$

$$S = \ln(1+i)$$

$$-800(1.07)^t - 50(1.07)^{t-1} + 100 \times (1.07)^{t-2} - 1 = 0$$

$$\ln(1.07)$$

$$t \rightarrow 17 \rightarrow -74.79 \quad 17.76 \rightarrow -0.757$$

$$18 \rightarrow 25.4626 \quad 17.77 \rightarrow 0.2426$$

$$17.7 \rightarrow -6.741 \quad 17.767 \rightarrow -0.057$$

$$17.8 \rightarrow 3.24632 \quad 17.768 \rightarrow 0.0426$$

$$\therefore t = 17.767 \text{ years}$$

b) Accumulated profit after 22 years is found by accumulating the income of year PPP has closed at 6% p.a.

$$100 \overline{S_{4.233}} @ 6\% = 100 \times \frac{(1+0.06)^{4.233} - 1}{\ln(1.06)}$$

$$= 480.0743066$$

$$\text{Accumulated amt} = \underline{480.0743066 \text{ Rs}}$$

e) i) The present value of outlay is

$$2.7 + \frac{0.2}{0.1} @ 9\%$$

The expected present value of the income is:

$$1.03 v^3 + \frac{0.2}{0.1} (0.25v + 0.2v^2 + 0.1v^3) @ 9\%$$

Equating the present value of the outlay to the present value of the income

$$2.7 + 0.2a_{\overline{3}|9\%} = 1.03v^3 + \frac{0.2}{0.1} (0.25v + 0.2v^2 + 0.1v^3) @ 9\%$$

ii) Based on the information present value of company's income is

$$0.1v^3 + 0.85a_{\overline{3}|9\%} v^3$$

$$0.1v^3 + 0.85a_{\overline{3}|9\%} - 2.7 - 0.2a_{\overline{3}|9\%} @ 9\% = 10\%$$

$$= 0.1 \times 0.7513 + 0.85 \times 0.7513 \times 6.4469 - 2.70 - 0.2 \times 2.4869$$

$$= 4.19 - 3.19$$

$$= 1.0089$$

Since NPV is positive it is worth to invest in the project.

9) TWR

$$(1+i)^3 = \frac{33 \times 41.05 - 4.5}{30.50} \times \frac{45.6}{41.05} \times \frac{47}{45.6 - 2.50}$$

$$(1+i)^3 = 1.08196713 \times 0.9371794872 \times 1.110840438 \times 1.090483$$

$$(1+i)^3 = 1.2281327$$

$$(1+i) = 1.070951281$$

$$i = 0.070951281$$

$$TWR = 7.0951281\%$$

MWRR

$$30.5(1+i)^3 + 6(1+i)^{2.25} + 4.5(1+i)^{1.5} - 2.5(1+i)^{0.5} - 47 = 0$$

$$\text{Let } 1+i = x$$

$$30.5x^3 + 6x^{2.25} + 4.5x^{1.5} - 2.5x^{0.5} - 47 = 0$$

$$1 \rightarrow -9$$

$$1.1 \rightarrow 2.9346$$

$$1.07 \rightarrow -0.867$$

$$1.08 \rightarrow 0.3782$$

$$1.076 \rightarrow -0.122$$

$$1.077 \rightarrow 0.00253507$$

$$1.072 \rightarrow -0.001107102193$$

$$1.0721 \rightarrow 0.0024587099$$

$$1.0713 \rightarrow 0.1716951665$$

$$1.07204 \rightarrow 0.000955463106$$

$$X = 1.07204$$

$$I = 0.07204$$

$$1+i = 1.07204$$

$$i = 7.204\%$$

ii. Linked rate of return

Year 2011 - Equation of value

$$30.5(1+i) + 6(1+i)^{0.25} = 38.50$$

$$\text{Let } (1+i) = x$$

$$30.5x + 6x^{0.25} - 38.50 = 0$$

$$1 \rightarrow -2$$

$$1.062 \rightarrow -0.018$$

$$1.1 \rightarrow 1.194682135$$

$$1.063 \rightarrow 0.0138$$

$$1.06 \rightarrow -0.081$$

$$1.0625 \rightarrow -0.0002120445693$$

$$1.07 \rightarrow 0.2373$$

$$1.0626 \rightarrow 0.001072882008$$

$$X = 1.0626$$

$$1+i = 1.0626$$

$$i = 0.0626 \text{ or } 6.26\%$$

Year 2012 - Equation of value

$$38.50(1+i) + 4.50(1+i)^{0.5} = 45$$

$$\text{Let } (1+i) = x$$

$$38.5x + 4.50x^{0.5} - 45 = 0$$

$$1 \rightarrow -2$$

$$1.049 \rightarrow -0.0045684$$

$$1.1 \rightarrow 2.0696$$

$$1.0492 \rightarrow 0.003570889029$$

$$1.04 \rightarrow -0.37$$

$$1.05 \rightarrow 0.0361$$

$$X = 1.0492$$

$$1+i = 1.0492$$

$$i = 0.0492 \text{ or } 4.92\%$$

Year 2013 = equation of value.

$$45(1+i)^0 - 2.5(1+i)^{0.5} = 47$$

$$45x - 2.5x^{0.5} - 47 = 0$$

$$1 \rightarrow 1.1 \rightarrow -0.172$$

$$1.11 \rightarrow 0.316$$

$$1.103 \rightarrow 0.0094012$$

$$1.2 \rightarrow 4.2013$$

$$1.102 \rightarrow -0.034404$$

$$1.1027 \rightarrow -0.00337$$

$$1.1028 \rightarrow 0.000642881435$$

$$1.10279 \rightarrow 0.000204324604$$

$$x = 1.10279$$

$$1+i = 1.10279$$

$$i = 0.10279 \text{ or } 10.279\%$$

Linked rate of return

$$(1+i)^3 = (1.0626)^4 (1.0492)^4 (1.010299)$$

$$(1+i)^3 = 1.229478427$$

$$1+i = 1.071289803$$

$$i = 0.071289803 \text{ or } 7.1289803\%$$

- iii) TWRR eliminates the effect of the cash-flow amount and time and $\therefore$ gives a fair basis for assessing the investment performance for the fund. M4WRR is sensitive to the amount of the net cash flows.

10) i) Let loan amount be Rs. L

$$L = 180000 a_{\overline{15}|i} + 20000 d_{\overline{15}|i} @ 12\%$$

$$L = 180000 \times 6.8109 + 20000 \times 40.7310 \left[\frac{1 - 1.12^{-15}}{0.12} \right]$$

$$= 180000 \times 6.8109 + 20000 \times \left(\frac{4.887760483}{0.12} \right)$$

$$= 1225962 + 20000 \times 40.73133739$$

$$= 1225962 + 814626.7479$$

$$= \underline{\underline{2040588}}$$

$$\text{Total cost of house} = \frac{2040588}{0.8} = 2550735$$

ii) The loan outstanding at the beginning of the 9th year

$$L = 180000 v + 180000 v^2 + \dots + 180000 v^8 + (9 \times 20000 v) + (10 \times 20000 v^2 + \dots + 15 \times 20000 v^8)$$

$$L(9) = 340000 a_{\overline{7}|i} + 20000 (5a_{\overline{7}|i}) @ 12\%$$

$$L(9) = 340000 \times 4.5638 + 20000 \left(\frac{5.1114 - 7 \times 0.45235}{0.12} \right)$$

$$L(9) = 1551672 + 824158.33 = \underline{\underline{Rs. 1875850.33}}$$

Loan Schedule

Year	Loan Bal	Loan Installment	Interest	Capital Repayment
9	1875850.33	360000	225102.04	134897.96
10	1740952.37	380000	208914.28	171085.92
11	1569866.65			

iii) Let the new installment be Rs. P

$$1569866.65 = P a_{\overline{5}|i} @ 10\%$$

$$1569866.65 = P \times 3.790786$$

$$P = \underline{\underline{414126.887}}$$

10) i) Let loan amount be ₹L

$$L = 180000 \text{ a.s.} + 20000 \text{ d.s.} @ 12\%$$

$$\ddot{a}_n = a_n \times \frac{1}{d}$$

$$L = 180000 \times 6.8109 + 20000 \times 40.7310 \left[\frac{\ddot{a}_n - 15v^{15}}{1} \right] \quad \begin{matrix} i = 0.12 \\ d = 0.107143 \end{matrix}$$

$$a_n = 6.8109$$

$$v = 0.892857$$

$$= 180000 \times 6.8109 + 20000 \times \left(\frac{4.287760483}{0.12} \right)$$

$$= 1225962 + 20000 \times 40.73133739$$

$$= 1225962 + 814626.7479$$

$$= \underline{\underline{2040588}}$$

$$\text{Total cost of house} = \frac{2040588}{0.8} = 2550735$$

ii) The loan outstanding at the beginning of the 9th year

$$L = 180000v + 180000v^2 + 180000v^3 + \dots + (15 \times 20000v^{15}) + (9 \times 20000v) + (0 \times 20000v^2)$$

$$L(9) = 340000 \text{ a.s.} + 20000 \text{ d.s.} @ 12\%$$

$$L(9) = 340000 \times 4.5638 + 20000 \left(\frac{5.1114 - 7 \times 0.45235}{0.12} \right)$$

$$L(9) = 1551672 + 324158.33 = \underline{\underline{1875850.33}}$$

Loan Schedule

Year	Loan a.s.	Loan Installment	Interest	Capital Repayment
9	1875850.33	360000	225102.04	134897.96
10	1740952.37	380000	208914.28	171085.92
11	159866.65			

iii) Let the new installment be ₹P

$$159866.65 = P \text{ a.s.} @ 10\%$$

$$159866.65 = P \times 3.790786$$

$$P = \underline{\underline{414126.887}}$$

Extra payment by Mr Sam if the loan continued with the first bank:
 Total installment = loan outstanding at the end of 10th year.
 $= (400000 + 420000 + 440000 + 460000 + 480000) = 15,67,866.65$
 $= 6,30,133.36$

Extra payment made by Mr Sam if the loan transferred to 2nd bank:
 Total installment + 1% processing fee = loan O/S at the end of 10th year
 $= 5 \times 441176.90 + 0.01 \times 15,67,866.65 = 15,69,866.65$
 $= 2,070,634.337 + 18,698.665 = 15,69,866.65$
 $= 5,16,466.35$

$\therefore$ the extra payment (interest + processing fee) to 2nd bank is lower than the payment to the first bank. It is advisable to Mr Sam to transfer the loan to 2nd bank.

10) Time weighted rate of return is given by:

$$(1+i)^2 = \frac{500}{460} \times \frac{600}{550} \left(\frac{550+50}{500+40} \right) \times x$$

$$(1+i)^2 = \frac{600}{46 \times 540 \times 11} x$$

$$(1+i)^2 = 1.44$$

$$1.44 \times 46 \times 540 \times 11 = x$$

$$x = 655.776$$

11) Money weighted rate of return is given by equation.

$$460(1+i)^2 + 40(1+i)^{7/4} - 50(1+i) = 655.776$$

$$\text{Let } 1+i = x$$

$$460x^2 + 40x^{7/4} - 50x - 655.776 = 0$$

$$1.1 \rightarrow -106.915622$$

$$0.198 \rightarrow -0.609$$

$$1.2 \rightarrow 1.6575$$

$$1.199 \rightarrow 0.5237$$

$$1.19 \rightarrow -96.356$$

$$1.1985 \rightarrow -0.04270952413$$

$$1.1986 \rightarrow 0.0704$$

$$1.19854 \rightarrow 0.0025233$$

$$(1+i) = 1.19854$$

$$i = 0.19854$$

$$i = 19.854\%$$

iii) The effective rate of return for year 2015 is given by solving the equation of value:-

$$460(1+i)^1 + 40(1+i)^{3/4} = 600$$

$$460x + 40x^{3/4} - 600 = 0$$

$$1.2 \rightarrow -2.138$$

$$1.204 \rightarrow -0.184$$

$$1.20433 \rightarrow 0.00121201$$

$$1.3 \rightarrow 46.698$$

$$1.205 \rightarrow 0.3044$$

$$1.21 \rightarrow 2.7475$$

$$1.2044 \rightarrow 0.01131495$$

$$1.2043 \rightarrow -0.037$$

$$1.18 = 1.202438$$

$$i = 0.202438 \text{ or } 20.2438\%$$

Effective rate of return for the year 2016

$$(1+i) = \frac{655.78}{550} = 1.92527$$

So linked rate of return is

$$(1+i)^2 = 1.92327 \times 1.202438$$

$$(1+i)^2 = 1.436015121$$

$$1+i = 1.198338483$$

$$i = 0.198338483 = 19.8338483\%$$

$$\text{LIRR} = 19.8338483\%$$

iv) When the sub-interval chosen for calculating LIRR coincide with the interval between net cash flow being received then the linked internal rate of return will be identical to time weighted rate of return.

v) ① TWR is a better measure of fund manager's performance.

② MWR is sensitive to the amount and timing of net cash flows, but fund manager does not have any control on that.

② TWR is calculated using "growth factor" reflecting the change in fund value between the time of consecutive cash flows. Thus TWR is independent of amount and timing of cash flows.

③ Hence TWR is better measure of fund manager's performance.

12) i) The discounted payback period of an investment ^{Project} period is the first time when the net present value of the cash flow from the project is positive.

ii) Let us work in units of 1000.

$$-800(1.07)^t - 50(1.07)^{t-1} + 100 \times \frac{1 - 1.07^{t-2}}{0.07} = 0$$

$$\text{or } -800(1.07)^t - 50(1.07)^{t-1} + 100 \times \frac{1 - 1.07^{t-2}}{0.07} = 0$$

$$S = \ln(1.07)$$

$$\frac{-800(1.07)^t - 50(1.07)^{t-1} + 100 \times \frac{1 - 1.07^{t-2}}{0.07}}{\ln(1.07)} = 0$$

$$t \rightarrow 17 \rightarrow -74.79$$

$$17.76 \rightarrow -0.757$$

$$18 \rightarrow 25.4626$$

$$17.77 \rightarrow 0.2426$$

$$17.7 \rightarrow -6.741$$

$$17.767 \rightarrow -0.057$$

$$17.8 \rightarrow 3.24632$$

$$17.768 \rightarrow 0.0426$$

$$\therefore t = 17.767 \text{ years}$$

b) Accumulated profit after 22 years is found by accumulating the income of year PPP has elapsed at 6% p.a.

$$100 \text{ invested at } 6\% = 100 \times \frac{(1 + 0.06)^{22} - 1}{0.06}$$

$$= 480.0743066$$

$$\text{Accumulated amt} = \underline{480.0743066 \text{ ru}}$$

13) i) Let $x/12$ be the monthly repayment. Solving the equation

$$X a_{\overline{27}|i}^{(12)} = 9880 @ 7\% \quad i = 0.067850$$

$$X a_{\overline{27}|i}^{(12)} = 9880 \quad a_{\overline{27}|i} = 11.6536$$

$$X (11.6536) \times 0.07 = 9880$$

$$0.067850$$

$$X = 821.7669096$$

$$X/12 = 68.4805758$$

Hence the monthly repayment 6848.05758

ii) Loan is immediately after repayment on 10th March 2021

$$X a_{\overline{34\frac{1}{3}}|i}^{(12)} = 64 \cdot 821.7669096 + (1 - (1/1.07)^{34\frac{1}{3}}) \cdot 6848.05758$$

$$0.067850$$

$$= 6485.745315 \text{ (in thousands)}$$

$$= 6485.745315 \quad 648,574.5315$$

iii) The loan is just after the repayment on 10th September 2026 made:

$$X a_{\overline{83\frac{1}{6}}|i}^{(12)} @ 7\%$$

The loan is just after the repayment on 10th October 2026 made

$$X a_{\overline{25\frac{1}{4}}|i}^{(12)} @ 7\%$$

$$\rightarrow X a_{\overline{13.75}|i}^{(12)} @ 7\%$$

Capital repaid on 10th October 2026 is thus

$$X \left[a_{\overline{83\frac{1}{6}}|i}^{(12)} - a_{\overline{25\frac{1}{4}}|i}^{(12)} \right] @ 7\%$$

$$X \left[\frac{v^{13.75} - v^{83\frac{1}{6}}}{i^{(12)}} \right] @ 7\%$$

$$X \left[\frac{(1/1.07)^{13.75} - (1/1.07)^{83\frac{1}{6}}}{0.067850} \right]$$

$$821.7669096 \left(0.03268447611 \right) = 26.85902093$$