Engineering Economics.

Introduction.

Types of Engineering Economic desicisions

1. Equipment or process selection
2. Equipment replacement
3. New product or product expansion
4. Cost reduction
5.

Decision Making Process.

1. Understand the problem
2. decision criteria identification
3. Allocate weights to the criteria.
4. Develop alternatives
5. Analyse Alternatives
6. Select best alternative
7. Implement
8. Monitor

Fundamental Principles of Engg Eco.

1. Time value of Money ⇒ invest small amt for large income
2. Analyse the differences
3. Invest more only if guaranteed increased revenue
4. Do not take additional risk if same return is expected

Value

- Measure of the worth that a person ascribes to a good or service.
- Value is independent of its utility.

Date
Page

Utility

- utility is a measure of the power of the good or a service to satisfy human wants

Macro and Micro Economics

Players in eco system → Govt, Firms, household, banks.

Macroeconomics deals with aggregate behaviour of the economy.
Focuses on issues such as - economic policies - inflation - deficit - GDP

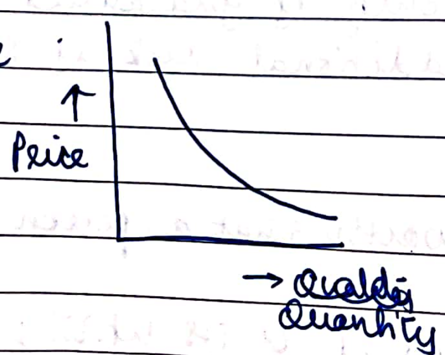
Microeconomics

- study of individuals, households in decision making and allocation of resources.
- deals with issues about what choices people make

Demand

- willingness of buyers to purchase a given amount of goods or services over a given period of time

Demand Curve :



Law of Demand: Principle stating that as the price of a commodity increases, the less consumers will purchase

Law of Demand: Underlying Effects
1. Substitution effect of price change.
2. Income effect of price change

Determinants of demand
General factors
1. price of the product
2. income of the consumer
3. prices of related goods.
Additional factors
1. consumer's expectations of future prices
2.

Changes in the prices of related goods
- Substitutes – coke, pepsi
- Complements. – bread, jam

Exceptions to Law of Demand
1. Giffen goods: inferior goods
2. Status goods: diamonds, cars.

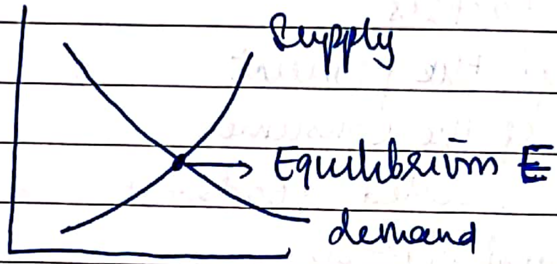
Supply
- willingness of producers to supply the good over range of prices keeping other factors constant.

Law of Supply
- quantity supplied of a good rises when the price of the

good rises and vice versa.

Determinants of supply
- price of the product
- production prices
- No of suppliers
- State of tech used
-

Supply and Demand Equilibrium.
Equilibrium:



Time Value of Money.

- Interest : rental amount charged by financial institutions.
- Interest rate : rate at which interest is paid by a borrower

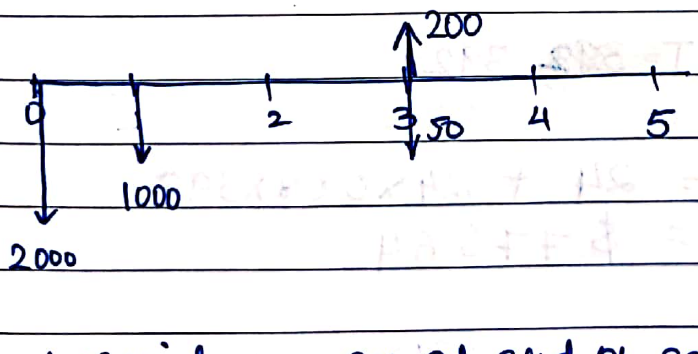
2 aspects of interest
- lenders viewpoint :- consumer goods, productive goods.
  Factors influencing - opportunity cost
  - probability that borrower will repay.
  - inflation.

- Borrowers viewpoint :- interest < expected gain

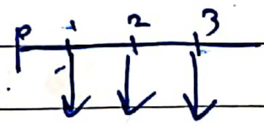
Money has earning power and purchasing power.
Relationship between time and ~~the~~ interest → Time Value.

Cash Flow Diagram.

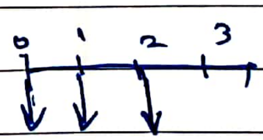
↓ → money goes out of system ↑ → money into system.



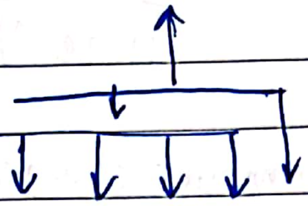
End of period → pay at end of each year.



Salvage value - ↑ at end of line.
beginning of period → pay before period begins
for 1st year at 0 2 at 1.



Types of Cash Flow:
- Single Payment.
- Equal Payment.
- Gradient Series



+g or −g

Simple Interest.

$$\boxed{F = P + (iP)N}$$

P = Principal i = rate
N = interest periods F = Amount

Compound Interest

Ex:

$n=0 : P$

$n=1 : F_1 = P(1+i)$

$n=2 : F_2 = F_1(1+i) = P(1+i)^2$

⋮

$$\boxed{n=N : F = P(1+i)^N}$$

Q. P = 24 T = ~~392~~ 392

R = 8 %.

SI

$F = 24 + 24 \times 0.08 \times 392$

$= \$ 776.64$

CI $= 24(1+0.08)^{392}$

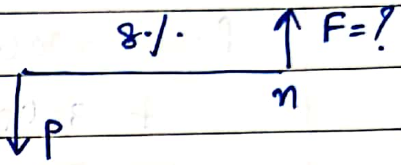
$=$ 3.036 trillion

Single Payment

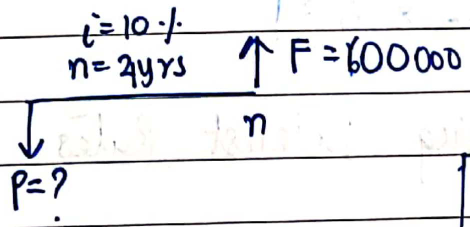
(1) $\boxed{F = P(1+i)^n \quad F = P(F/P, i, n)}$ → to find amt.

$\Rightarrow$ F given P] – single payment compound amount factor.

eg: $\$100 = P$ $i = 8\%$ $n = 10$ yrs.
factor from table = 2.1589.
$\therefore F = 100 \times 2.1589$.
$= \$\ 215.89$



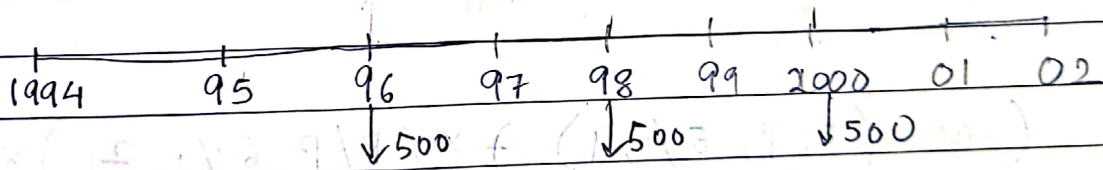
eg



(2) $\boxed{P = F\left[\frac{1}{(1+i)^n}\right] \quad P = F(P/F, i, n)}$ → to find P.

$P = 600000 \times 0.6830$
$= 409800$

Q3

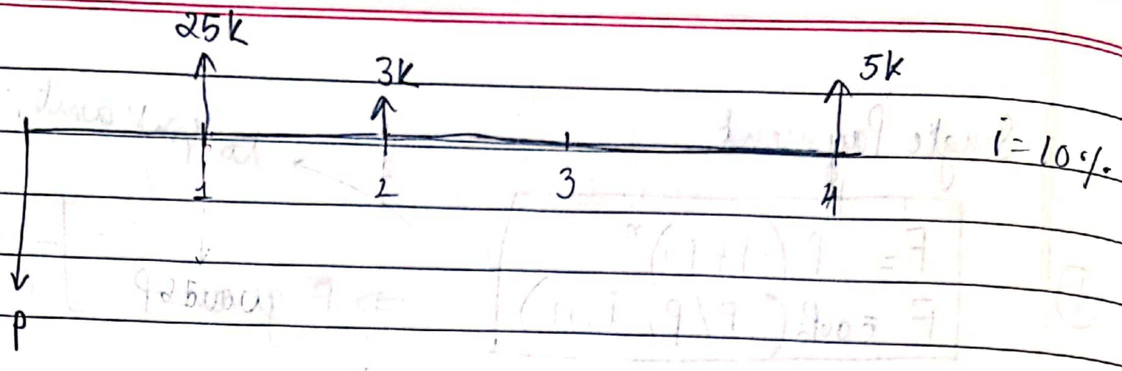


In 1996, $500 \times 1.1449 = 572.45$
$\therefore$ In 1998 → 1072.45
$\therefore$ In 1998 $1072.45 \times 1.1449 = 1227.85$
$\therefore$ in 2000 → $1227.85 + 500$
$= 1727.85$

$\therefore$ Final Amt $= 1727.85 \times 1.1449$
$= ₹\ 1978.21$

We can even take each 500 separately
$500(F/P, i, 6) + 500(F/P, i, 4) + 500(F/P, i, 2)$

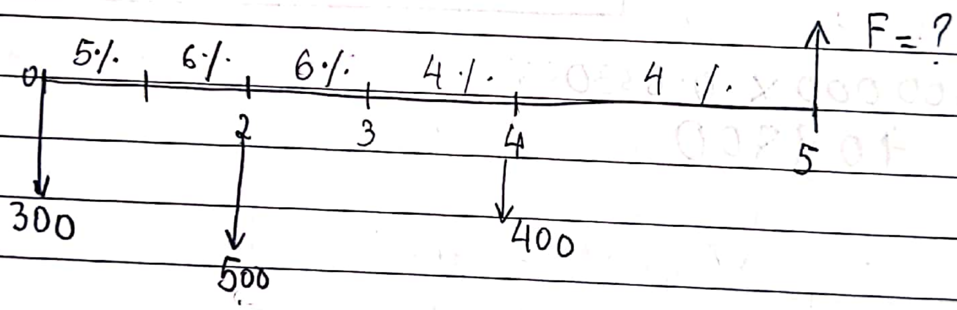
Q 6.



$$P = 25000\,(P/F, 10\%, 1) + 3000\,(P/F, 10\%, 2) + 5000\,(P/F, 10\%, 4)$$

$$25000 \times 0.9091 + 3000 \times 0.8624 + 5000 \times 0.6830 = \$28621$$

Uneven Series with varying Interest Rates.



$$(300 \times (F/P, 5\%, 1)) \times (F/P, 6\%, 2) \times (F/P, 4\%, 2)$$
$$+$$
$$(500 \times (F/P, 6, 1)) \times (F/P, 4, 2)$$
$$+$$
$$400 \times (F/P, 4, 1)$$

$$= 300 \times 1.0500 \times 1.1236 \times 1.0816 \qquad 382.82$$
$$+ \qquad\qquad +$$
$$500 \times 1.0600 \times 1.0816 \qquad 573.25$$
$$+ \qquad\qquad +$$
$$400 \times 1.0400 \qquad 416$$

$$= \underline{1372.07}$$

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Q2. $F = P(1+i)^n$

$40 = 20(1+i)^5$

$i = 14.86\%$

* $(F/P, i, n) = 2.$ So check page in table where factor is 2.

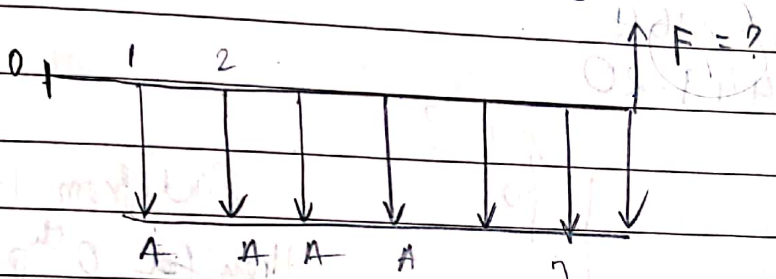
Q5. $F = P(1+i)^n$

$2x = x(1+0.20)^n$

$2 = (1+0.20)^n$

$n = 3.8$ years

Equal payment Series (Annual worth / Annuities)



$F = A(1+i)^{n-1} + A(1+i)^{n-2} + \dots + A(1+i) + A$

$F = A + A(1+i) \dots + A(1+i)^{n-1} \longrightarrow (1)$

$1 \times (1+i)$

$F(1+i) = A(1+i) + A(1+i)^2 \dots + A(1+i)^n \longrightarrow (2)$

(2) − (1)

$F(1+i) - F = -A + A(1+i)^n$

$$F = A\left[\frac{(1+i)^n - 1}{i}\right]$$

$$\boxed{= A(F/A, i, n)}$$

$\Rightarrow$ Equal Series payment compound factor.

Given final amount, find equal payments.

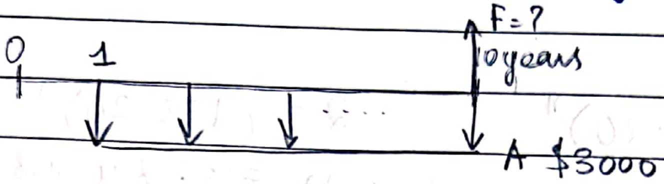
$$A = F\left[\frac{i}{(1+i)^n - 1}\right]$$

$$\boxed{A = f(A/F, i, n)}$$

Sinking fund factor

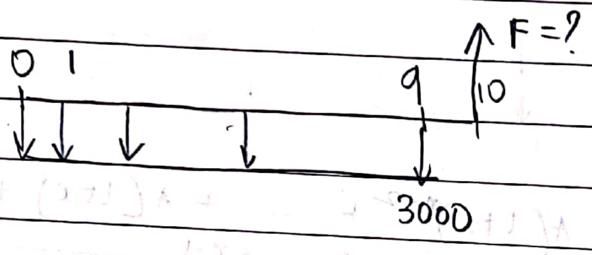
Sinking fund is an interest bearing account into which a fixed sum is deposited each interest period for the purpose of fixed assets.

Q7. a)



$$F = A(F/A, i, n)$$
$$= 3000\,(F/A, 7, 10)$$
$$= 3000 \times 13.8164$$
$$= \$\ 41449.20$$

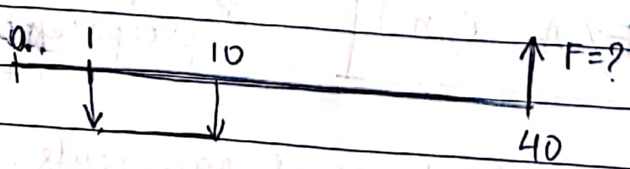
b)



Find from 1-9 then for 0th payment find F.

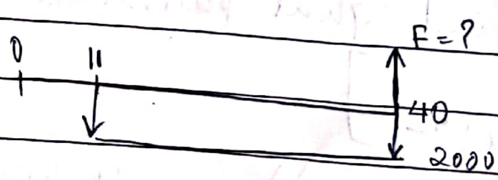
$$F = 3000\,(F/A, 7, 9) \times (F/P, 7, 1) + 3000\,(F/P, 7, 10)$$
$$= \cancel{3000 \times 11.9780 \times 1 + 3000 \times 8.6540}$$
$$\cancel{25960}$$
$$= 3000 \times 11.9780 \times 1.0700 + 3000 \times 1.9672$$
$$= \cancel{4129.414}\ 44350$$

Q8. a)

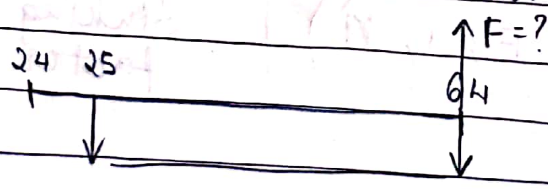


$i = 8\%$

b)



c)

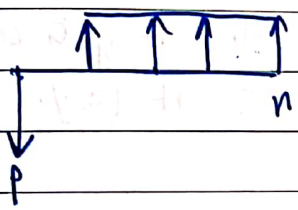


c) $F = 2000(F/A, 8, 40)$
$= 2000 \times 259.0565 = \$ 518113$

b) $F = 2000 (F/A, 8, 30)$
$= 2000 \times 113.2832 = 226568.$

a) $F = 2000 (F/A, 8, 10) \times (F/P \times 8, 30)$
$= 2000 \times 14.4866 \times 10.0627$
$= \cancel{28476}\ 291548.62.$

Capital Recovery Factor



$$A = F\left[\frac{i}{(1+i)^n - 1}\right]$$

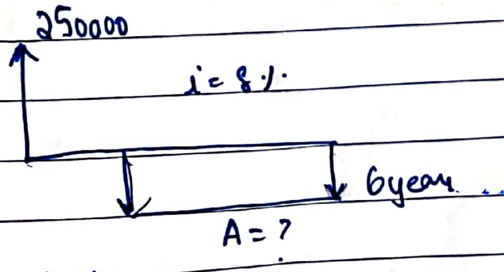
$$A = P\left[\frac{i(1+i)^n}{(1+i)^n - 1}\right]$$

$$\boxed{= P(A/P, i, n)} \rightarrow \text{Capital Recovery factor.}$$

$$P = A\left[\frac{(1+i)^n - 1}{i(1+i)^n}\right] = \boxed{A\,(P/A, i, n)}$$ — Equal payment series with worth factor

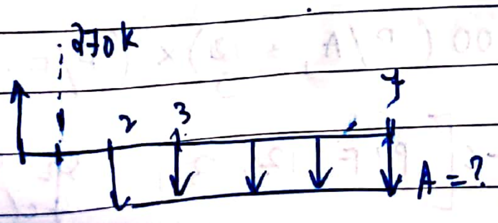
* Present worth is calculated one year prior to 1st payment

Q9.



a) $A = 250000(A/P, 8, 6)$
$= 250000 \times 0.2163$
$= 54075.$

b)



$X_1 = 250000 (F/P, 8, 1)$
$A = 270,000 (A/P, 8, 6)$

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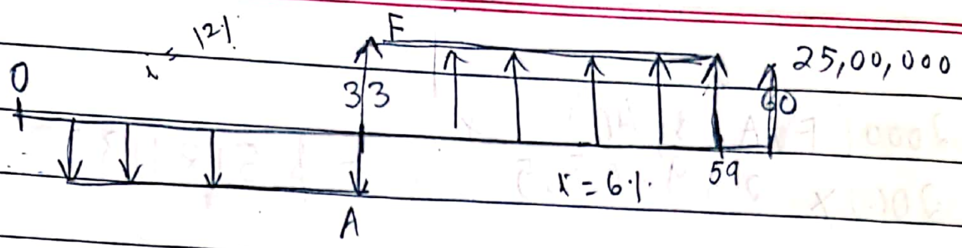
Q10.



Bring future amounts to 33.
Start from 34 − 59 ⇒ 26 payments.

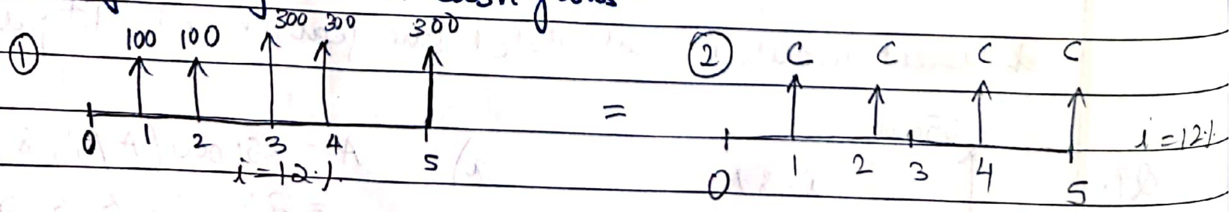
X_{33} = 180 000 (P/A, 6, 26) ⇒ this will
+ accumulated one ~~dee~~ year prior ⇒ 33.
180000 (33rd year payment)
+
2500000 (P/F, 6, 27)

(Can also calc from 33 − 59) and then it gets accumulated at 32, then we get it ahead to 33 at 12%.

Rs 30,39,076.

A = 30,39,076 (A/F, 12, 33)
A = 8,813.3

Q. The following are 2 cash flows.



What is C?

in ①

P_1 = 100 (P/A, 12, 2) + 300 (P/A, 12, 3) × (P/F, 12, 2)

P_2 = C [P/A, 12, 5] − C [P/F, 12, 3] or C(P/A, 12, 2) + C(P/A, 12, 2) × (P/F, 12, 3)

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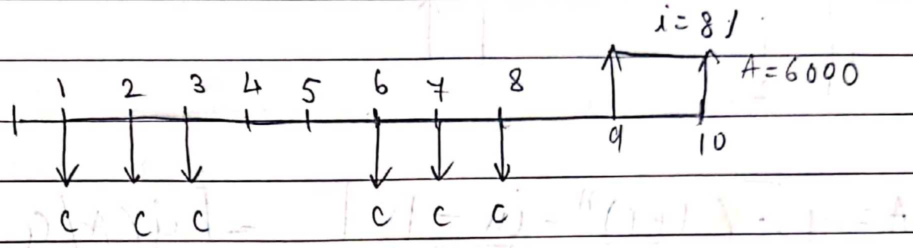
$P_1 = P_2$

$C = 256.97$

Q. Find the value of c that will establish economic equivalence between the deposit series and withdrawal series (9,10) at 8% p.a.



→ amount in end will be 0.

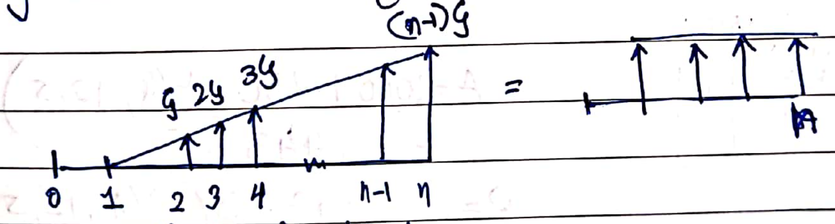
$F_{10} = c(F/A, 8, 3) \times (F/P, 8, 2) + \cancel{c(F/A, 8, 3)}$
$c(P/A, 8, 3)(F/P, 8, 10)$

$=$

$6000(F/A, 8, 2)$

$c = 1334.76$

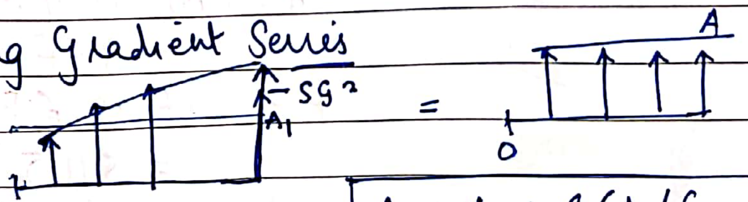
Gradient Series (A/G, P/G)



Strict Gradient

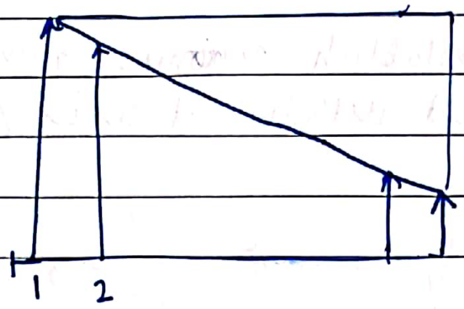
Gradient series involves periodic payment that increase or decrease by a constant amount g from period to period

Increasing Gradient Series



$$\boxed{A = A_1 + G(A/G, i, n)}$$

Decreasing Gradient Series

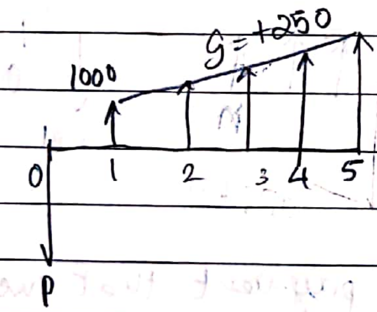


$A = A - G(A/G, i, n)$

$$A = G\left[\frac{(1+i)^n - in - 1}{i[(1+i)^n - 1]}\right] = \boxed{G(A/G, i, n)}$$

$$P = G\left[\frac{(1+i)^n - in - 1}{i^2(1+i)^n}\right] = \boxed{G(P/G, i, n)}$$

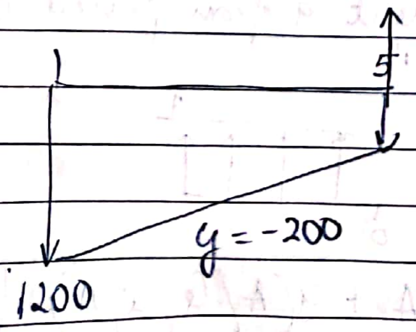
Q.11



$A = 1000 + 250(A/G, 12, 5)$
$= 1443.65$

$P = 1443.65(P/A, 12, 5)$
$= 5204$

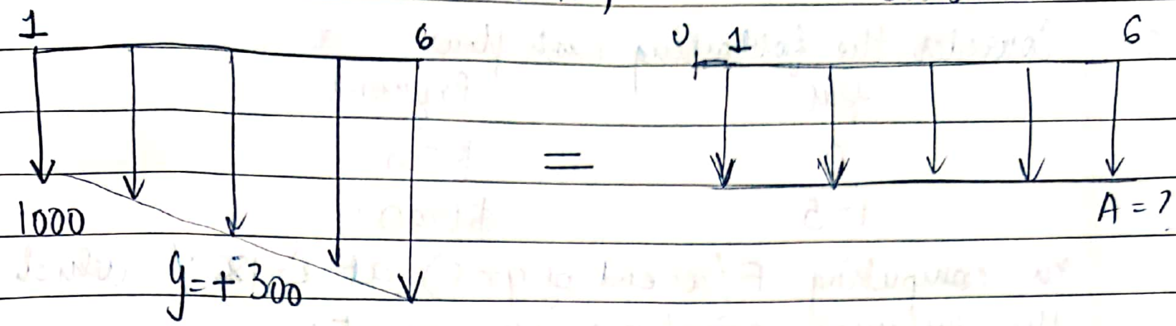
Q12.



$A = 1200 - 200(A/G, 10\%, 5)$
$= 837.98$

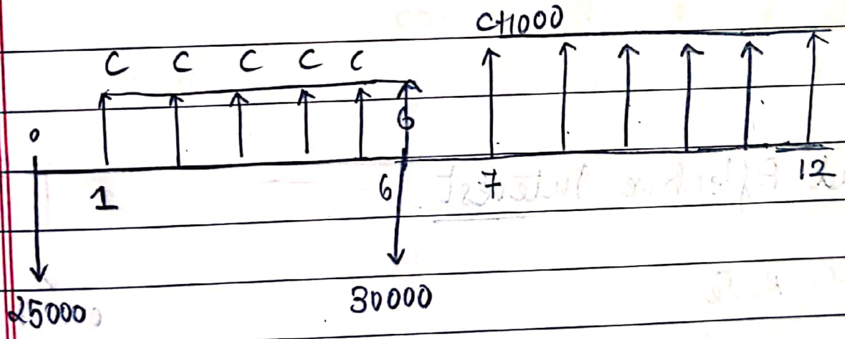
$F = 837.98\,(F/A, 10, 5)$
$= 5115$

Q13.



$$A = 1000 + 300(A/G, 10, 6)$$
$$1000 + 300 \times 2.2236$$
$$= 1667.08$$

Q. Henry Cisco is planning to make 2 deposits of 25000\$ now, & 30000\$ at the end of year 6. He wants to withdraw an amt C at the end of each yr for the first 6 years and C+1000 for the next 6 years. Find C if i=10%. Find it with the least amount of factors.



we can bring it to 0 or take to 12.

Get amounts to 12th year. deposits

$$25000(F/P, 10, 12) + 30000(F/P, 10, 6)$$
$$=$$
$$C+1000(F/A, 10, 6) + C(F/A, 10, 6)(F/P, 10, 6)$$

OR. Get amts to 6th year.

$$25k(F/P, 10, 6) + 30k = C(F/A, 10, 6) + C+1000(P/A, 10, 6)$$

C+1000

Q. Consider the following cash flow

Year	Payment
0	\$500
1-5	\$1000.

In computing F (at end of yr 5) at $i = 12\%$ which of the following equations are correct.

a) $F = \$1000(F/A, 12, 5) - 500(F/P, 12, 5)$

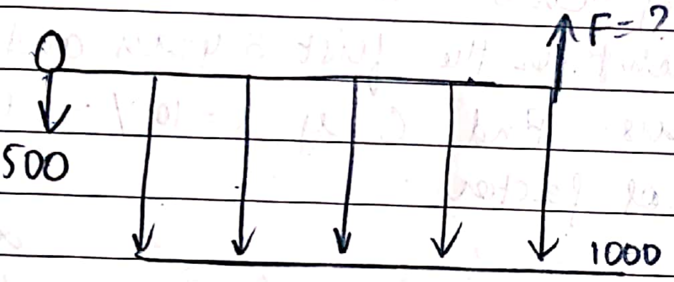
b) $F = \$500(F/A, 12, 6) + 500(F/A, 12, 5)$

c) $F = [500 + 1000(P/A, 12, 5)](F/P, 12, 5)$

d) $F = (500(A/P, 12, 5) + 1000)(F/A, 12, 5)$

Can split 1000 into 500-500

Convert into annuity.



Nominal and Effective Interest.

APR - Annual % Rate

Nominal interest rate - for namesake, not real.

If APR, or 'compounded yearly/monthly/quarterly' is mentioned next to rate then its nominal.

Calculate Effective interest rate for the payment period

Effective Interest Rate is that one rate that truly represents the interest earned during that time period.

Nominal rate always for a year → yearly basis.

Nominal Annual Semi-annual Quarterly Monthly Daily

① General

CP- compounding period
PP - payment period.

$$i_{eff}/pp = \left(1+\frac{r}{m}\right)^{c}-1$$

r = Normal rate
m = No of CP/year
c = No of CP/PP.

② Making Payments Annually.

$$i_{eff_a} = \left(1+\frac{r}{m}\right)^{m}-1.$$

③ CP = PP.

$$i_{eff} = r/m.$$

1. 12% compounded monthly, i_{eff}/year = ?

$$i_{eff}/year = \left(1+\frac{r}{m}\right)^{m}-1 = \left(1+\frac{0.12}{12}\right)^{12}-1$$

=

2. Nominal 18% comp weekly, i_{eff_a} = ?

$$i_{eff_a} = \left(1+\frac{r}{m}\right)^{m}-1$$

$$= \left(1+\frac{0.18}{52}\right)^{52}-1$$

Date
Page

3. 14% comp monthly, i eff / six months = ?

$$\left(1+\frac{r}{m}\right)^{c}-1 = \left(1+\frac{0.14}{12}\right)^{6}-1$$

$= 7.20\%$ / six months.

CP = 1
PP = 6

4. 10% comp weekly, pp = 6 months.

$$\left(1+\frac{r}{m}\right)^{c}-1 = \left(1+\frac{0.10}{52}\right)^{26}-1$$

CP = 1 week
PP = 6 months

$= 5.12\%$ / six months

5. 9% comp semiannually, PP = 2 years.

$$\left(1+\frac{r}{m}\right)^{c}-1$$

CP = 6 months
PP = 2 years

$$= \left(1+\frac{0.09}{2}\right)^{4}-1$$

6. 10% comp Quarterly ~~monthly~~ payments

$$\left(1+\frac{0.10}{4}\right)^{1/3} = 0.826\%$$

per month.

CP = 3 mos
PP = 1 month

Q4 (Qbank)

$r = 1.8\%$ per month
Compounded mothly

a) 1.8 / month × 12 = 21.6%.

b) Effective i eff/a = $\left(1+\frac{r}{m}\right)^{m}-1$

CP = 1 month

$$= \left(1+\frac{0.216}{12}\right)^{12}-1 = 23.8\% = \text{i eff /a.}$$

c) $F = P(1+i)^{n}$

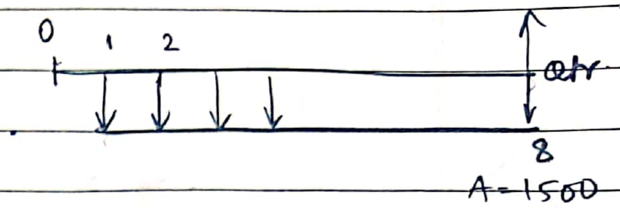
$3F = P(1+i)^{n}$ $\quad 3 = (1+0.018)^{n}$ $\quad n = 61.58$ months $= 5.31$ yrs

if we use 23.8% then we get n in years

Q1. $i = 6\%$ compounded monthly.

~~$i_{eff}/a = \left(1 + \frac{0.06}{12}\right)^{12} - 1$~~

CP = 1mm
PP = 3mm



$$i_{eff}/qtr = \left(1 + \frac{0.06}{12}\right)^{3} - 1$$

$$= 1.507\% \text{ per Qtr}$$

$$F = A\left[\frac{(1+i)^n - 1}{i}\right]$$

$$F = 1500\left[\frac{(1 + 0.1507)^{8} - 1}{0.1507}\right]$$

$$= \$12651.6$$

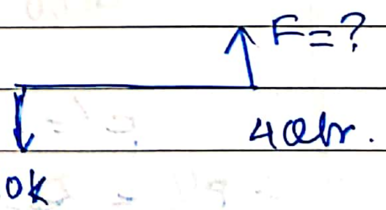
Q2. PP = 1 month CP - 3 months.

$$i_{eff}/month = \left(1 + \frac{0.01}{4}\right)^{1/3} - 1 = 0.00083$$
$$= 0.83\%.$$

$$F = A\left[\frac{(1+i)^n - 1}{i}\right]$$

$$F = 500\left[\frac{(1 + 0.00083)^{120} - 1}{0.00083}\right] = \$102188.18.$$

Q3. 9% comp Quarterly.

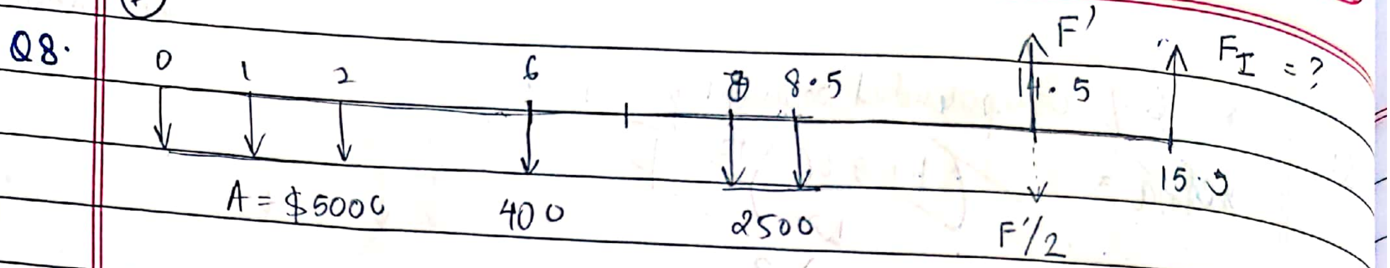


$$i_{eff}/a = \left(1 + \frac{0.09}{4}\right)^{4} - 1 = 9.3\%$$

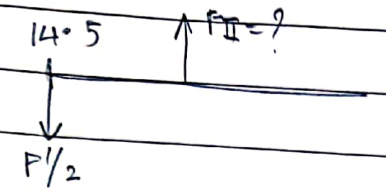
$$F = 10000(1 + 0.93)^4$$
$$F = \$10930.$$

Scanned by CamScanner

Q8. (I)



(II)



8% comp quaterly

6% comp monthly

ieff a. , ieff / 6months for (1).
ieff a for (2).

$$i_{eff}a = \left(1+\frac{0.06}{12}\right)^{12}-1 = 6.167\%.$$

$$i_{eff}/6mos = \left(1+\frac{0.06}{12}\right)^{6}-1 = 3.03\% \text{ for 6mos}$$

CP = 1 month
PP = 6mos

→ 5000(F/A, 6.167, 3). Now get to 14, and 6seeing ahead by 0.5 year using deff rate

→ 5000(F/A, 6.167, 3)(F/P, 3.03, 25)
+
4000 (F/P, 3.03, 17) + [2500(F/P, 3.03, 1) + 2500] (F/P, 6.167, 6)

F' = ~~502,540~~ 46459.2 (at 14.5 years)

∴ F'/2 = ~~25270~~ 232926.6

ieff/a for 8%.

$$\left(1+\frac{0.08}{4}\right)^4 -1 = 8.243\%.$$

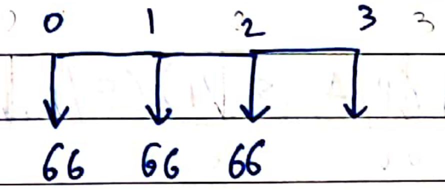
∴ F_1 = ~~25270~~ 232926.6 (F/P, 6.671, 1) ⇒ 27353.

F_2 = ~~25270~~ 232926.6 (F/P, 8.243, 1) = 25115.84

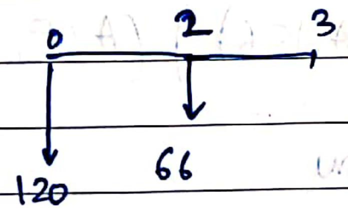
A Journal offers 3 types of subscription.
1 year @ \$ 66
2 years @ \$ 120
3 years @ \$ 169
payable in advance. If i is 6% compounded monthly, which subscription should you take? Justify.
Assume subscription duration = 3 yrs.

$$i_{eff}/a = \left(1 + \frac{0.06}{12}\right)^{12} - 1 = 6.167\%$$ CP = 1 month

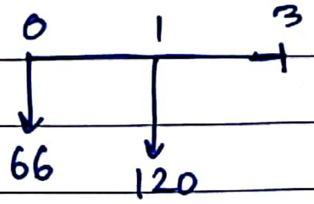
Options

① 

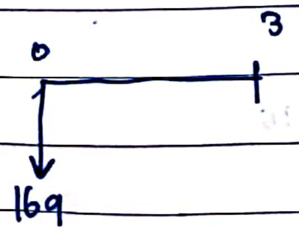
$\Rightarrow$ $66 + 66\,(P/A,\ 6.167,\ 2)$

② 

$\Rightarrow$ $120 + 66\,(P/F,\ 6.167,\ 2)$

③ 

$\Rightarrow$ $66 + 120\,(P/F,\ 6.167,\ 1)$

④ 

$\Rightarrow$ 169

A low cost temperature measuring tool will save the railways 25000 per quarter in the years 1-5. This savings is expected to increase by \$2500 every quarter in the years 6-20. What is the annual worth of the savings over the 20 years. $i = 12\%$ compounded quarterly.

Q. The following equation describes the conversion of a cash flow into an equivalent equal payment series with $n=20$

$$A = \{[50 + 25(A/G, 15, 10)](F/A, 15, 10)(F/P, 15, 10)$$
$$+$$
$$[500 - 10(A/G, 15, 10)](F/A, 15, 10)$$
$$-$$
$$[200 + 100(A/G, 15, 4)](P/A, 15, 4)(F/P, 15, 20)$$
$$-$$
$$[1300 + 100(A/G, 15, 4)](F/A, 15, 4)(F/P, 15, 10)$$
$$-$$
$$[1200 - 200(A/G, 15, 6)](F/A, 15, 6)\}(A/F, 15, 20)$$

Reconstruct the original cash flow