

CHAPTER 4

14 MARKS

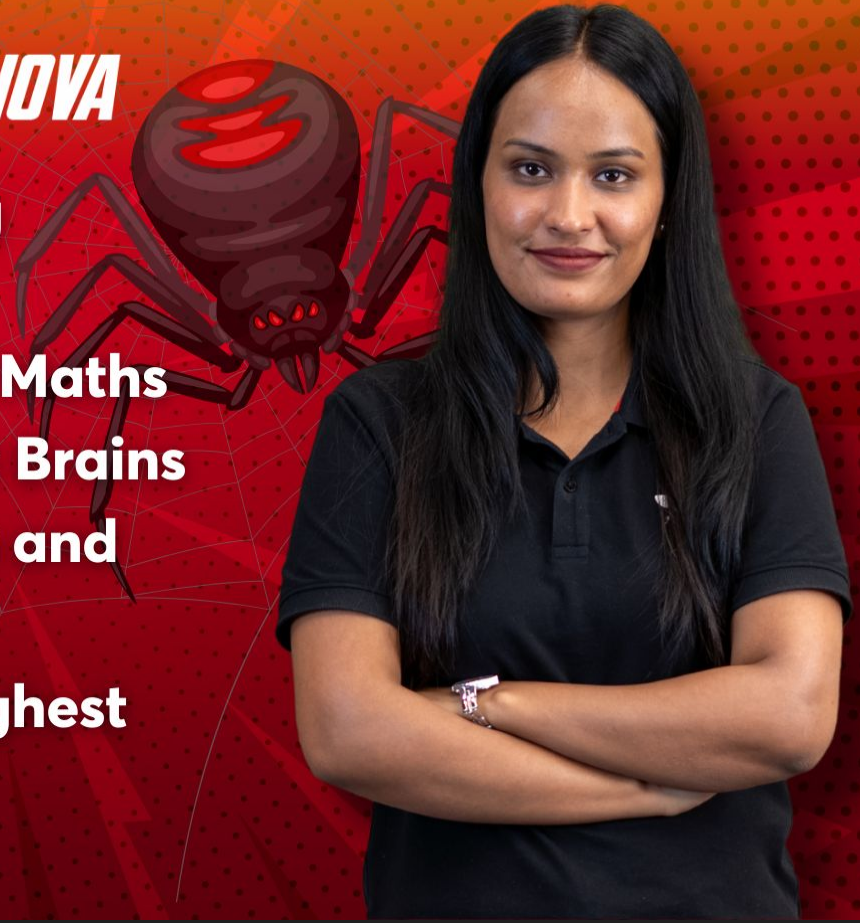
MATHEMATICS OF FINANCE

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- **7 years** of experience in teaching **Mathematics**
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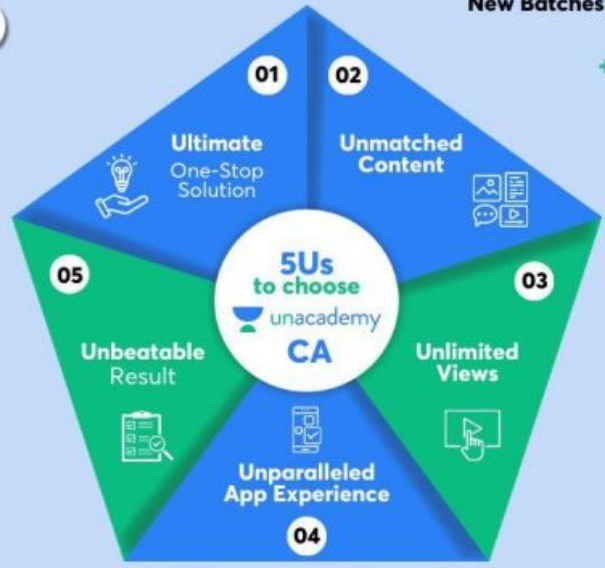
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TERMS

INTEREST

Interest is the price paid by a borrower for the use of a lender's money. If you borrow (or lend) some money from (or to) a person for a particular period you would pay (or receive) more money than your initial borrowing (or lending). This excess money paid (or received) is called *interest*.

PRINCIPAL

- Principal is initial value of lending (or borrowing).



TERMS

RATE OF INTEREST

- The rate at which the interest is charged for a defined length of time for use of principal generally on a yearly basis is known to be *the rate of interest*.
- Rate of interest is usually as expressed as percentages.
- Per annum means for a year.

ACCUMULATED BALANCE

- Accumulated amount is the final value of an investment. It is the sum total of principal and interest earned.
- Amount is also known as the balance.

Inflation

Time value of money

Why interest
is paid ?

Liquidity
Preference

Opportunity Cost

Risk factor

SIMPLE INTEREST

- Simple interest is the interest computed on the principal for the entire period of borrowing .
- It is calculated on the principal amount only and not on interest previously earned.
- Value of interest remains constant for each year.
- Difference between amount of any two consecutive years is equal to interest of a year

$$SI = \frac{P.r.t}{100}$$

P = principal value

r = rate of interest per annum

t = time period in years

SIMPLE INTEREST

- $$A = P + SI$$
$$= P + \frac{P \cdot r \cdot t}{100}$$

$$A = P \left(1 + \frac{r t}{100} \right)$$

A = Amount

P = principal value

r = rate of interest per annum

t = time period in years

June 2012 , Dec 2012

t = time period in years

Que. Simple interest on ₹ 2,000 for 5 months at 16% p.a. is _____.

- (a) ₹ 133.33
- (b) ₹ 133.26
- (c) ₹ 134.00
- (d) ₹ 132.09

Ans : a

FEB 2007

- **Value of interest remains constant for each year.**

A sum of money doubles itself in 10 years when deposited on simple interest . it would triple itself in

- a) 25 years
- b) 15 years
- c) 20 years
- d) None

Ans : c

June 2022

The annual rate of simple interest is 12.5 % . In how many years does the principal doubles ?

- a) 11 years
- b) 9 years
- c) 8 years
- d) 7 years

Ans : c

June 2019

In simple interest if the principal is ₹ 2000 and the rate and time are the roots of the equation $x^2 - 11x + 30 = 0$ then simple interest is

- a) ₹ 500
- b) ₹ 600
- c) ₹ 700
- d) ₹ 800

Ans : b

May 2018

A person borrows ₹ 5000 for 2 years at 4% per annum simple interest . He immediately lends to another person at $6\frac{1}{4}\%$. per annum for 2 years find his gain in the transaction per year

- a) ₹ 112.50
- b) ₹ 225
- c) ₹ 125
- d) ₹ 107.50

Ans : a

June 2011

Que. If a simple interest on a sum of money at 6% p.a. for 7 years is equal to twice of simple interest on another sum for 9 years at 5% p.a.. The ratio will be:

(a) 2 : 15

(b) 7 : 15

(c) 15 : 7

(d) 1 : 7

Ans : c

Dec 2021

Que. An amount is lent at $R\%$ simple interest for R years and the simple interest amount was one-fourth of the principal amount. Then R is

(a) 5

(b) 6

(c) $5^{1/2}$

(d) $6^{1/2}$

Ans : a

Dec 2022

Que. A farmer borrowed ₹ 3,600 at the rate of 15% simple interest per Annum. At the end of 4 years, he cleared this account by paying ₹ 4,000 and a cow. The cost of the cow is:

- (a) ₹ 1,000
- (b) ₹ 1,200
- (c) ₹ 1,550
- (d) ₹ 1,760

Ans : d



COMPOUND INTEREST

- **We can define the compound interest as the interest that accrues when earnings for each specified period of time added to the principal thus increasing the principal base on which subsequent interest is computed.**

COMPOUND INTEREST

- The period at the end of which the interest is compounded is called conversion period.

Conversion period	Description	Number of conversion period in a year
1 day	Compounded daily	365
1 month	Compounded monthly	12
3 months	Compounded quarterly	4
6 months	Compounded semi annually	2
12 months	Compounded annually	1

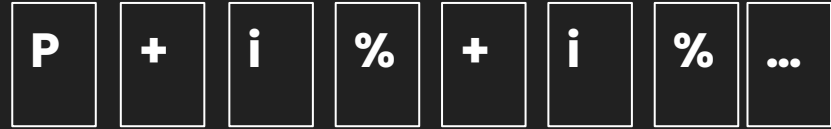
$$A_n = P(1+i)^n$$

$$\text{where, } i = \frac{\text{Annual rate of interest}}{\text{Number of conversion periods per year}}$$

$$\begin{aligned}\text{Interest} &= A_n - P = P(1+i)^n - P \\ &= P[(1+i)^n - 1]\end{aligned}$$

n is total conversions i.e. t x no. of conversions per year

CALCULATOR TRICK TO FIND AMOUNT



June 2023

The compound interest on ₹ 15, 625 for 9 months at 16 % per annum compounded quarterly is

- a) ₹ 1851
- b) ₹ 1941
- c) ₹ 1951
- d) ₹ 1961

Ans : c

June 2023

Que. The population of a town increase by 2% of the population at the beginning of the year. The number of year by which the total increases in population would be 40% is:

- (a) 7 years**
- (b) 10 years**
- (c) 17 years**
- (d) 19 years (approx)**

Ans : b

**Dec 2014,
2022**

Que. A sum of money invested of compound interest doubles itself in four years. In how many years it become 32 times of itself at the same rate of compound interest?

- (a) 12 Years**
- (b) 16 Years**
- (c) 20 Years**
- (d) 24 Years**

Ans : c

June 2019

Que. A sum was invested for 3 years as per C.I and the rate of interest for first year is 9% , 2nd year is 6% and 3rd year is 3 % pa . respectively . Find the sum if the amount in three years is

₹ 550

(a) 250

(b) 300

(c) 462.16

(d) 350

Ans : c

Que. The ratio of principal and the compound interest value for three years (compounded annually) is 216 : 127. The rate of interest is:

- (a) 0.1777
- (b) 0.1567
- (c) 0.1666
- (d) 0.1587

Ans : C

Que. A sum of money is lent at C.I. Rate 20% p.a. 2 years. It would fetch ₹ 482 more if the interest is compounded half yearly. The sum is:

- (a) ₹ 19,800
- (b) ₹ 19,900
- (c) ₹ 20,000
- (d) ₹ 20,100

Ans : c

Dec 2021

Que. A sum of money is put at 20% compound interest rate p.a. At which year the aggregated amount just exceeds the double of the original sum ?

(a) 5

(b) 6

(c) 4

(d) 3

Ans : c

Dec 2022

Que. Mr. Prakash invested money in two schemes 'A' and 'B' offering compound interest at the rate of 8% and 9% per annum respectively. If the total amount of interest accrued through these two schemes together in two years was ₹ 4,818.30 and total amount invested was ₹ 27,000. What was the amount invested in schemes 'A'?

- (a) ₹ 12,000
- (b) ₹ 12,500
- (c) ₹ 13,000
- (d) ₹ 13,500

Ans : a

June 2023

Que. The difference between compound interest and simple interest on an a certain sum of money invested for 3 years at 6% per annum is ₹ 110.16 . The principle is

- (a) ₹ 3000
- (b) ₹ 3700
- (c) ₹ 12,000
- (d) ₹ 10,000

Ans : d

June 2022

Que. There is 60% increase in an amount in 6 years at simple interest .
What will be the compound interest of ₹ 12, 000 after 3 years at the same rate ?

- (a) ₹ 3972
- (b) ₹ 2160
- (c) ₹ 3120
- (d) ₹ 3742

Ans : a

EFFECTIVE RATE OF INTEREST

- **Effective interest rate can be defined as the equivalent annual rate of interest compounded annually if interest is compounded more than once in a year.**
- **But if interest is compounded annually effective interest rate for the year will be equal to actual interest rate per annum.**

EFFECTIVE RATE OF INTEREST

**The effective interest rate can be computed directly
by following formula:**

$$E = (1 + i)^n - 1$$

Where E is the effective interest rate

i = actual interest rate in decimal

n = number of conversion period

Que. Which is a better investment 9% p.a. compounded quarterly or 9.1% p.a. simple interest?

(a) 9% compounded

(b) 9.1% S.I.

(c) Both are same

(d) Cannot be said

Ans : a

June 2023

Que. The nominal rate of interest is 10% per annum . The interest is compounded quarterly . The effective rate of interest per annum will be

- (a) 10%**
- (b) 10.10%**
- (c) 10.25 %**
- (d) 10.38%**

Ans : d

June 2019

Que. The effective rate of interest does not depend upon

- (a) Amount of Principal**
- (b) Amount of Interest**
- (c) Number of Conversion Periods**
- (d) None of these**

Ans : a

DEPRECIATION

Depreciation is the fall in the value of an asset due to wear and tear , efflux of time , obsolescence .

$$A = P(1 - i)^n$$

Where ,

P = historical cost of asset

A = Scrap value / residual value

n = no . of periods

i = depreciation

June 2023

Que. A machine depreciates at 10% of its value at the beginning of a year. The cost and scrap value realized at the time of sale being ₹ 23,240 and ₹ 9,000 respectively. For how many years the machine was put to use?

- (a) 7
- (b) 8
- (c) 9
- (d) 10

Ans : c

Que. The value of furniture depreciates by 10% a year, if the present value of the furniture in an office is ₹ 21,870, calculate the value of furniture 3 years ago

(a) ₹ 30,000

(b) ₹ 35,000

(c) ₹ 40,000

(d) ₹ 50,000

Ans : a

Que. The value of scooter is ₹ 10,000 find its value after 7 years if rate of depreciation is 10% p.a.

(a) ₹ 4,782.96

(b) ₹ 4,278.69

(c) ₹ 42,079

(d) ₹ 42,000

Ans : a

SINGLE CASH FLOW

If single amount is paid or received initially and then direct finally at the end .

Example : FD

FUTURE VALUE : SINGLE CASH FLOW

- Future value is the cash
- value of an investment at some time in the future.

- $F = C.F. (1 + i)^n$

PRESENT VALUE : SINGLE CASH FLOW

- Present value is today's value of tomorrow's money discounted at the interest rate.

-

$$P = \frac{C.F.}{(1+i)^n}$$

Que. You invest 3000 in a two year investment that pays you 12% per annum . Calculate the future value of the investment

(a) 3360

(b) 3900

(c) 3720

(d) 3763.2

Ans : d

Nov 2020

Que. Find the present value of 1,00,000 to be required after 5 years if the interest rate be 9% . Given $1.09^5 = 1.5386$

(a) 78995.98

(b) 64994.15

(c) 88,992.43

(d) 93,902.12

Ans : b

ANNUITY

FEATURES :

- Amount paid (or received) must be constant over the period of annuity
- Time interval between two consecutive payments (or receipts) must be the same.

Year end	Payments/Receipts (₹)
I	5,000
II	6,000
III	4,000
IV	5,000
V	7,000

NOT ANNUITY

Year end	Payments/Receipts (₹)
I	5,000
II	5,000
III	-
IV	5,000
V	5,000

NOT ANNUITY

Year end	Payments/Receipts (₹)
I	5,000
II	5,000
III	5,000
IV	5,000
V	5,000

ANNUITY

TYPES ANNUITY

Annuity

**NOT
MENTIONED**

Annuity regular

**First payment/receipt at
the end of the period**

**Annuity due or annuity
immediate**

**First payment/receipt at
the beginning of the period**

FUTURE VALUE OF ANNUITY

FUTURE VALUE OF ANNUITY REGULAR

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

Where ,
A = periodic payments

FUTURE VALUE OF ANNUITY DUE

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

Where ,
A = periodic payments

Jan 2021

Que. Find the future value of annuity of 1,000 made annually for 7 year at interest rate of 14% compounded annually (Given that $1.14^7 = 2.5023$)

(a) ₹ 10,730.7

(b) ₹ 5,365.35

(c) ₹ 8,756

(d) ₹ 9892.34

Ans : a

Jan 2021

Que. ₹ 800 is invested at the end of each month in an account paying interest 6% per year compounded monthly. What is the future value of this annually after 10th payment?

- (a) ₹ 4,444
- (b) ₹ 8,756
- (c) ₹ 3,491
- (d) ₹ 8,182

Ans : d

June 2019

Que. Let a person invest a fixed sum at the end of each month in an account paying interest 12% per year compounded monthly. If the future value of this annuity after the 12th payment is Rs. 55,000 then the amount invested every month is?

(a) ₹ 4,837

(b) ₹ 4,637

(c) ₹ 4,337

(d) ₹ 3,337

Ans : c



SINKING FUND

- **It is the fund credited for a specified purpose by way of sequence of periodic payments over a time period at a specified interest rate.**
- **Interest is compounded at the end of every period.**
- **Size of the sinking fund deposit is same as **future value of Annuity** .**

Dec 2022

Que. How much amount is required to be invested every year so as to accumulate ₹ 5,00,000 at the end of 12 years if interest is compounded annually at 10%? (Where $A(12,0.1) = 21.384284$).

- (a) ₹ 23381.65
- (b) ₹ 24385.85
- (c) ₹ 26381.65
- (d) ₹ 28362.75

Ans : a

June 2023

Que. A company want to replace its existing tool room machine at the end of 10 years, the expected cost of machine would be ₹ 10,00,000. If management of the company creates a sinking fund, how much provision needs to be made out of revenue each year which can earn at the rate of 10% compounded annually? Given $A(10,0.10) = 15.937425$

- (a) ₹ 74,625
- (b) ₹ 72,514
- (c) ₹ 62,745
- (d) ₹ 67,245

Ans : c

June 2021

Que. Suppose you have decided to make a Systematic Investment Plan (SIP) in a mutual fund with 1,00,000 every year from today for next 10 years where you get return at the rate of 10% per annum compounded annually. What is the future value of this annuity? Given $1.1^{10} = 2.59374$

- (a) ₹ 17,35,114
- (b) ₹ 17,53,411
- (c) ₹ 17,35,411
- (d) ₹ 17,53,114

Ans : d

Dec 2022

Que. Raju invests ₹ 20,000 every year in a deposit scheme starting from today for next 12 years. Assuming that interest rate on this deposit is 7% per annum compounded annually. What will be the future value of this annuity? Given that $(1 + 0.07)^{12} = 2.25219159$.

(a) ₹ 5,40,526

(b) ₹ 3,82,813

(c) ₹ 6,43,483

(d) ₹ 3,57,769

Ans : b

PRESENT VALUE OF ANNUITY

PRESENT VALUE OF ANNUITY REGULAR

$$PVAR = A \times PVAF(n, i)$$

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

PRESENT VALUE OF ANNUITY DUE

$$PVAD = A \times PVAF\{(n-1), i\} + A$$

Where ,
A = periodic payments

PVAF CALCULATOR TRICK :

$$1+i \div = = = = \dots n \text{ times } GT$$

June 2022

Que. ₹ 2,500 is paid every year for 10 years to pay off a loan. What is the loan amount if interest rate be 14% p.a. Compounded annually?

(a) ₹ 15,847.90

(b) ₹ 13,040.27

(c) ₹ 14,674.21

(d) ₹ 16,345.11

Ans : b

Jan 2021

Que. The present value of an Annuity immediate is the same as

- (a) Annuity regular for $(n-1)$ year plus the initial receipt in the beginning of the period**
- (b) Annuity regular for $(n-1)$ years**
- (c) Annuity regular for $(n+1)$ years**
- (d) Annuity regular for $(n+1)$ years plus the initial receipt in the beginning of the period**

Ans : a

June 2023

Que. Govinda's mother decides to gift him ₹ 50,000 every year starting from today for the next five years. Govinda deposits this amount in a bank as and when he receives and gets 10% per annum interest rate, compounded annually. What is the present value of this annuity?

Given $P(4.0.10) = 3.16987$

(a) ₹ 2,80,493.5

(b) ₹ 2,08,493.5

(c) ₹ 2,08,943.5

(d) ₹ 2,58,493.5

Ans : b

July 2021

Que. A loan of ₹ 1,02,000 is to be paid back in two equal installments . If the rate of interest is 4% p.a , compounded annually , then the total interest charged (in ₹) under this installment plan is

- (a) 6160
- (b) 8120
- (c) 5980
- (d) 7560

Ans : a

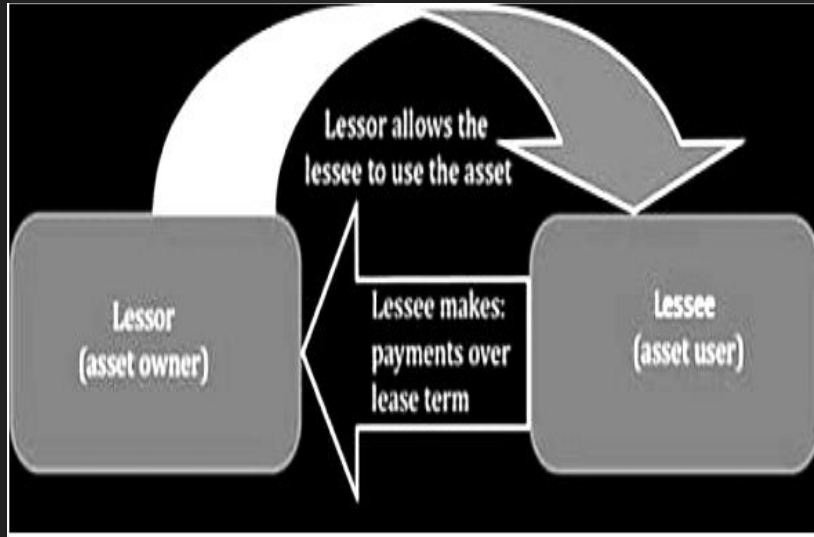
June 2023

Que. A car is available for ₹ 4,98,200 cash payment or ₹ 60,000 cash down payment followed by three equal annual installments. If the rate of interest charged is 14% per annum compounded yearly, then total interest charged in the installment plan is (Given $P(3,0.14) = 2.32163$):

- (a) ₹ 1,46,314
- (b) ₹ 1,46,137
- (c) ₹ 1,28,040
- (d) ₹ 1,58,040

Ans : c

LEASING



- Leasing is a financial arrangement under which the **owner of the asset (lessor)** allows the **user of the asset (lessee)** to use the asset for a defined period of time (lease period) **for a consideration (lease rental) payable over a given period of time. This is a kind of taking an asset on rent.**

HOW TO SOLVE QUESTION ?

Present value of Lease rentals are compared with asset cash down price to decide if leasing is preferable or not.

June 2019

Que. A person wants to lease out a machine costing 5,00,000 for a 10 year period. It has fixed a rental of 51272 per annum payable annually starting from the end of first year . Suppose rate of interest is 10% per annum , compounded annually on which money can be invested . To whom this agreement is favourable ?

- (a) Favour for lessee**
- (b) Favour for lessor**
- (c) Not for Both**
- (d) Can't be determined**

Ans : a

CAPITAL EXPENDITURE (INVESTMENT DECISION)

- Capital expenditure means purchasing an asset (which results in outflows of money) today in anticipation of benefits (cash inflow) which would flow across the life of the investment.

**Purchase Asset
or Not ?**



How will decision be taken ?

- Compare purchase value of asset with the present value of future benefits .
- If present value of future benefit is greater than purchase value of asset ,decision should be in the favour of investment

Que. A machine can be purchased for 50,000 . Machine will be contributing 12,000 per year for the next five years . Assuming borrowing cost is 10% per annum . Determine whether machine should be purchased or not

- (a) Should be purchased**
- (b) Should not be purchased**
- (c) Can't say about purchase**
- (d) none of the above**

Ans : b

PERPETUITY

- Perpetuity is an annuity in which the periodic payments or receipts begin on a fixed date and continue indefinitely or perpetually .
- We can calculate PV of Perpetuity .
- FV of Perpetuity is not defined .

$$PVP = \frac{A}{i}$$

PVP = Present Value of Perpetuity

A = Installment (Annuity Value)

i = adjusted interest rate

June 2019

Que. Determine the present value of perpetuity of ₹ 50,000 per month at the interest rate of 12 % pa

(a) ₹ 4500000

(b) ₹ 5000000

(c) ₹ 5500000

(d) ₹ 6000000

Ans : b

GROWING PERPETUITY

- A stream of cash flows that grows at a constant rate forever is known as growing perpetuity.

$$PVGP = \frac{A}{i - g}$$

PVGP = Present Value of Growing Perpetuity

A = Installment (Annuity Value)

i = adjusted interest rate

g = growth rate

June 2022

Que. Assuming that the discount rate is 7% p.a. How much would you pay to receive ₹ 200. Growing at 5% annually forever?

(a) ₹ 2,500

(b) ₹ 5000

(c) ₹ 7,500

(d) ₹ 10,000

Ans : d

June 2023

Que. If the discount rate is 10% per annum, how much amount would you pay to receive ₹ 2,500 growing at 8%, annually forever?

(a) ₹ 1,25,000

(b) ₹ 2,50,000

(c) ₹ 1,50,000

(d) ₹ 2,00,000

Ans : a



NET PRESENT VALUE

Net present value (**NPV**) = Present value of cash inflow – Present value of cash outflow

Decision Rule:

If $NPV > 0$ Accept the Proposal

If $NPV < 0$ Reject the Proposal

July 2021

Que. If the cost of capital be 12% per annum, then the net present value (in nearest ₹) from the given cash flow is given as

Year	0	1	2	3
Operating profit (in thousands ₹)	(100)	60	40	50

- (a) 31048
- (b) 34185
- (c) 51048
- (d) 21, 048

Ans : d



REAL RATE OF RETURN

- **Real Rate of Return = Nominal Rate of Return – Inflation**

July 2021

Que. If the nominal rate of growth is 17% and inflation is 9% for the five years. Let P be the Gross Domestic Product (GDP) amount at the present year then the projected real GDP after 6 years is

- a) 1.587 P
- b) 1.921 P
- c) 1.403P
- d) 2.51 P

Ans : a

June 2023

COMPOUND ANNUAL GROWTH RATE

Que. Ms. Paul invested ₹ 1,00,000 in a mutual fund scheme in January 2018. After one year in January, 2019, she got a dividend amounting to ₹ 10,000 for first year. ₹ 12,000 for second year. ₹ 16,000 for third year, ₹ 18,000 for fourth year and 21,000 for fifth year in January 2023. What is Compounded Annual Growth Rate (CAGR) of dividend return? Given $1.2038^4 = 2.1$.

- (a) 20.38%
- (b) 18.59%
- (c) 16.36%
- (d) 15.89%

Ans : a