MAT142 FINANCIAL FORMULAS REFERENCE SHEET

Simple One-time Interest

$$I = P_0 r$$
$$A = P_0 + I = P_0 + P_0 r = P_0(1 + r)$$

Simple Interest Over Time

$$I = P_0 rt$$
$$A = P_0 + I = P_0 + P_0 rt = P_0(1 + rt)$$

Discounted Loan

$$M = P - I \text{ or } P = M + I$$

Compound Interest Discretely

$$P_N = P_0\left(1 + \frac{r}{k}\right)^{Nk}$$

Compound Interest Continuously

$$P_N = P_0 e^{rN}$$

Annuity Formula

$$P_N = \frac{d\left(\left(1+\frac{r}{k}\right)^{Nk} - 1\right)}{\frac{r}{k}}$$

Payout Annuity and Loan Formula

$$P_0 = \frac{d\left(1-\left(1+\frac{r}{k}\right)^{-Nk}\right)}{\frac{r}{k}}$$

A is the end amount: principal plus interest.
d is the amount of the periodic deposit or payment in the annuity formulas.
e is the usual math class base for natural exponential and log functions.
I is the amount of the interest.
k is the number of compoundings or deposits per t unit (typically years).
M is the discounted amount received by the borrower.
N is the number of years.
P is the principal (starting amount).
P_N is the balance in the account after N years.
P_0 is the principal (starting amount).
r is the interest rate in decimal form (Example: 5% = 0.05).
t is the time, typically in years.

MAT142 FINANCIAL FORMULAS REFERENCE DETAILS

Simple One-time Interest

$$I = P_0 r$$

$$A = P_0 + I = P_0 + P_0 r = P_0(1 + r)$$

I is the interest.
A is the end amount: principal plus interest.
P_0 is the principal (starting amount).
r is the interest rate in decimal form (Example: 5% = 0.05).

Simple Interest Over Time

$$I = P_0 r t$$

$$A = P_0 + I = P_0 + P_0 r t = P_0(1 + r t)$$

I is the interest.
A is the end amount: principal plus interest.
P_0 is the principal (starting amount).
r is the interest rate in decimal form (Example: 5% = 0.05).
t is time of the loan.

NOTE: Simple One-Time Interest is just Simple Interest Over Time with t = 1.

Discounted Loan

In a discounted loan the amount P is not the amount received by the borrower, but rather the total amount the borrower agrees to pay back after a set time period.

$M = P - I$ or $M = P - prt$

($I = prt$)

$P = M + I$

I is the interest (the discount).
M is the actual amount received by the borrower.
P is the nominal loan amount, to be repaid by the borrower.
r is the interest rate in decimal form (Example: 5% = 0.05)
t is time of the loan.

Compound Interest Discretely

$$P_N = P_0\left(1 + \frac{r}{k}\right)^{Nk}$$

P_N is the balance in the account after N years.
P_0 is the principal (starting amount).
r is the annual interest rate (in decimal form. Example: 5% = 0.05).
k is the number of compounding periods in one year.
N is the number of years.

When do you use this?

Compounding is paying interest on the accumulating previous interest payments as well as the original principal. The formula applies when money is invested once at the beginning of the time period. Use this formula when a specific number of compoundings per year is stated either directly (e.g. interest is compounded 4 times per year, so k=4) or indirectly (e.g. interest is compounded semiannually, so k=2).

Compound Interest Continuously

$$P_N = P_0 e^{rN}$$

P_N is the balance in the account after *N* years.
P_0 is the principal (starting amount).
r is the annual interest rate (in decimal form. Example: 5% = 0.05).
N is the number of years .

When do you use this?

Use only when the problem specifically states that the interest is compounded continuously. The output of this formula is the limit of the discrete interest as the number of compoundings per years approaches infinity.

Annuity Formula

$$P_N = \frac{d\left(\left(1+\frac{r}{k}\right)^{Nk} - 1\right)}{\frac{r}{k}}$$

P_N is the balance in the account after *N* years.
d is the regular deposit (the amount you deposit each year, each month, etc.).
r is the annual interest rate (in decimal form. Example: 5% = 0.05).
k is the number of compounding periods and the number of deposits in one yea r.
N is the number of years we plan to take withdrawals or the length of the loan.

When do you use this?

This formula is for the case in which money is invested in the account on a regular schedule (every month, year, quarter, etc.) and is left there earning interest. No withdrawals are made during the time period.

To help select the correct formula, remember that compound interest assumes money is put into the account once and left there earning interest.

Compound interest:	One deposit
Annuity:	Many deposits

Payout Annuity and Loan Formula

$$P_0 = \frac{d\left(1-\left(1+\frac{r}{k}\right)^{-Nk}\right)}{\frac{r}{k}}$$

P_0 is the balance in the account, or the amount of the loan, at the beginning (starting amount, or principal).
d is the regular withdrawal from the annuity or payment on the loan (the amount you take out each year, each month, etc., or pay to the lender)
r is the annual interest rate (in decimal form. Example: 5% = 0.05)
k is the number of compounding periods in one year.
N is the number of years we plan to take withdrawals or the length of the loan.

If the compounding frequency is not explicitly stated, assume there are the same number of compounds in a year as there are withdrawals made in a year.

When do you use this?

Payout annuities assume that you take money from the account on a regular schedule (every month, year, quarter, etc.) and let the rest sit there accumulating interest.

Compound interest: One deposit
Annuity: Many deposits.
Payout Annuity: Many withdrawals

Note: To find remaining principal on a loan after a certain period of time, use this formula to determine P_0 for the given payments schedule.