



## How to use Fast Formulas Spreadsheets

The tabs at the bottom of the spreadsheet contain different subjects.  
Click on one of the tabs to display the subject that interests you.

Enter values into the light blue cells, the ones that look like this one:

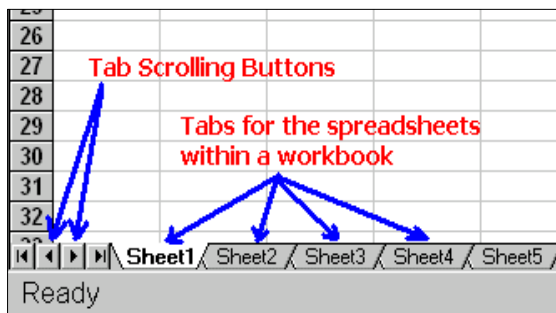


When you have entered values into the cells, the result of the formula appears in the cells with the red border, like this one:



## Help Using Spreadsheet Tabs


The spreadsheet tabs in Microsoft Excel are located at the bottom-left side of the Excel Window as shown here:

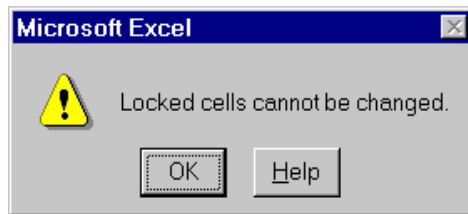


To switch between sheets in a workbook, click the sheet tab for the sheet you want to work on.

If you don't see the tab you want, click the tab scrolling buttons to display the tab. Then click the tab.

## Protected Cells

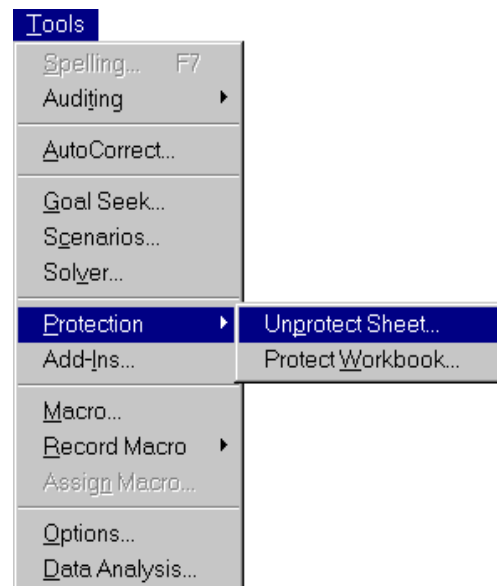
When you attempt to change cells that are not light blue-colored (  ) a message box appears that looks like this:



This is because the sheets are "protected" so that they are not accidentally disturbed in unintended ways.

However, if you are comfortable working with formulas in MS Excel, you may wish to edit the formulas to adapt them to other uses. You can easily disable the protection feature as follows:

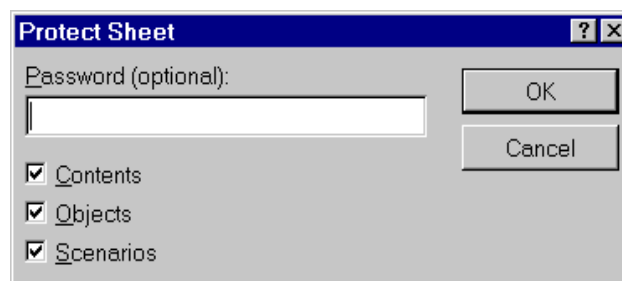
- 1 Select the tab that you wish to "Un-Protect"
- 2 Click the Tools menu, and choose the Protection menu item and then click "Unprotect Sheet..."
- 3 The sheet is now unprotected, allowing you to make any changes you wish.  
BE CAREFUL!



You can easily "re-protect" a sheet that you have unprotected, as follows:

- 1 Select the tab that you wish to protect
- 2 Click the Tools menu, and choose the Protection menu item and then click "Protect Sheet..."

The following dialog box will appear:





- 3 To protect the sheet without requiring a password to unprotect it later, click the OK button.

To protect the sheet so that a password is required to unprotect it later, type a password into the box, and then click the OK button.

**DON'T FORGET THAT PASSWORD! WRITE IT DOWN SOMEWHERE.**

Fast Formulas can not rescue you from forgotten passwords!



Thank you for purchasing this spreadsheet from Fast Formulas. We hope that you find it useful.

We offer interactive spreadsheets in the following areas, and are in the process of developing others.

Business: Accounting  
Business: Finance  
Business: Marketing  
Business: Statistics  
Business: Operations Management

Engineering: Economics  
Civil Engineering: Statics  
Civil Engineering: Dynamics  
Electrical Engineering: AC Circuits  
Electrical Engineering: DC Circuits  
Electrical Engineering: Electronics  
Electrical Engineering: Electrostatics  
Electrical Engineering: Three Phase  
Electrical Engineering: Rotating Machines  
Mechanical Engineering: Fluids - Properties  
Mechanical Engineering: Fluids - Statics

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Your Fast Formulas Username

Product Name

Tab Name

Formula Name

A description of the problem

The values for each of the variables in the formula which causes the bug to appear.

We will do our best to resolve the problem as quickly as possible and to provide you with a solution to the problem. We welcome your feedback and appreciate your patience while we find a solution.

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<http://www.fastformulas.com/ffshop/faq.asp>

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Requests for new Subjects	<a href="mailto:requests@fastformulas.com">requests@fastformulas.com</a>

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## Finance Formulas

## Financial Ratio Analysis

Tax Rate

Input Data	Year 1	Year 2	Year 3	Year 4
Revenues				
Cost of Goods Sold				
Gross Margin	0	0	0	0
Operating Expenses				
Interest (before tax)				
Income (before tax)	0	0	0	0
Income Tax (Current + Deferred)				
Net Income	0	0	0	0
Dividends				
Cash				
Accounts Receivables				
Other Liquid Current Assets				
Inventory				
Current Assets	0	0	0	0
Property, Plant and Equipment				
Investments and Other Assets				
Total Assets	0	0	0	0
Current Liabilities				
Long Term Debt				
Other Long Term Liabilities				
Total Liabilities	0	0	0	0
Working Capital	0	0	0	0
Shareholders Equity				
Market price per Common Stock share				
Number of Common Stock shares				
Cash Expenses				
Cash from Operations				



Ratios	Year 1	Year 2	Year 3	Year 4
<b>OVERALL</b>				
Price / Earnings (P/E)	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
Return on Assets (ROA)	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
Return on Invested Capital (ROIC)	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
Return on Shareholders Equity (ROSE)	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
<b>PROFITABILITY</b>				
Gross Margin % (GM)	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
Profit Margin	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
Earnings Per Share (EPS)	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
<b>INVESTMENT UTILIZATION</b>				
Asset Turnover	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
Invested Capital Turnover	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
Equity Turnover	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
Capital Intensity	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
Days' Cash	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
Days' Receivables (or collection period)	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
Days' Inventory	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
Inventory Turnover	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
Working Capital Turnover	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
<b>FINANCIAL CONDITION</b>				
Current Ratio	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
Acid Test (Quick Ratio)	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
Debt / Equity Ratio	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
Debt / Capitalization Ratio	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
Times Interest Earned	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
Cash Flow / Debt	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
Dividend Yield	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
Dividend Payout	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!

**The Finance Formulas spreadsheet available for purchase at [www.fastformulas.com](http://www.fastformulas.com) includes the following financial formulas and analyses:**

Equivalent Pre-Tax Yield On Taxable Investment	Bond Present Worth
Inflation Premium	Bond Valuation (Annual Compounding)
Nominal Interest Rate	Bond Valuation (Semi-Annual Compounding)
Risk Free Rate Of Interest	Conversion Price
Average Sales Per Day	Price Of Callable Bond
Cash Flow Coverage Financial Ratio	Value Of Long-Term And Short-Term Annual Coupon Bonds At Different Market Interest Rates
Current Financial Ratio	Yield To Maturity
Days Sales Outstanding	Optimal Amount Of Cash Raised By Selling Marketable Securities Or By Borrowing
Debt Financial Ratio	Baumol Model
Earnings Per Share	Annual Savings

Fixed Assets Turnover Financial Ratio	Average Sales Per Day
Inventory Turnover Financial Ratio	Cost Of Carrying Receivables
Market / Book Financial Ratio	Credit Score
Price / Earnings Financial Ratio	Days Sales Outstanding
Profit Margin On Sales	Total Cost Of Cash Balances
Quick Financial Ratio Or Acid Test Financial Ratio	Average Inventory
Return On Common Equity	Economic Order Quantity
Return On Total Assets	Inventory Management
Times-Interest-Earned Financial Ratio	Reorder Point
Total Assets Turnover Financial Ratio	Total Carrying Cost
Break Even Quantity	Total Inventory Cost
Break Even Sales	Total Ordering Cost
Cash Operating Break Even Quantity	Annual Percentage Rate
Contribution Margin	Approximate Cost Of Foregoing A Cash Discount
Degree Of Financial Leverage	Compensating Balance Requirement
Degree Of Financial Leverage - If NO Preferred Stock Exists	Effective Annual Rate
Degree Of Financial Leverage - If Preferred Stock Exists	Periodic Rate
Degree Of Operating Leverage	Periodic Rate (Discount)
Degree Of Operating Leverage - At A Particular Operating Level	Required Loan Amount
Degree Of Operating Leverage - At A Particular Sales Level	Usable Funds
Degree Of Total Leverage	Capital Budgeting Evaluation
Degree Of Total Leverage - If NO Preferred Stock Exists	Coefficient Of Variation
Degree Of Total Leverage - If Preferred Stock Exists	Comparison Of Multiple Projects
Earnings Before Interest And Taxes	Expected Net Present Value
Earnings Before Interest And Taxes - Financial Break Even Point	Incremental Operating Cash Flow
Full Capacity Sales	Net Cash Flow
Gross Profit Margin	Net Present Value
Total Cost	Payback
Beta Coefficient Of A Portfolio	Required Rate Of Return For A Project
Coefficient Of Variation	Standard Deviation Of The Net Present Value
Expected Rate Of Return	After Tax Component Cost Of Debt
Expected Rate Of Return On A Portfolio	Bond Yield + Risk Premium Approach To Stock Valuation
Market Risk Premium	Break Point
Security Market Line	Capital Asset Pricing Model
Standard Deviation	Component Cost Of Preferred Stock
Variance	Constant Growth Rate Approach To Stock Valuation
Effective Annual Rate	Cost Of New Common Equity
Future Value	Discounted Cash Flow Approach To Stock Valuation
Future Value Of An Annuity	Marginal Cost Of Capital Schedule
Future Value Of An Annuity Due	Required Rate Of Return
Future Value Of An Uneven Cash Flow Stream	Required Rate Of Return
Future Value With Frequent Compounding	Weighted Average Cost Of Capital
Periodic Interest Rate	Weighted Average Cost Of Capital
Present Value	Degree Of Financial Leverage

Present Value Of A Perpetuity	Degree Of Financial Leverage - If NO Preferred Stock Exists
Present Value Of An Uneven Cash Flow Stream	Degree Of Financial Leverage - If Preferred Stock Exists
Simple, Quoted Interest Rate Per Period	Degree Of Operating Leverage
Time Value Of Money Calculator	Degree Of Operating Leverage - At A Particular Operating Level
Preferred Stock Valuation	Degree Of Operating Leverage - At A Particular Sales Level
Intrinsic (Theoretical) Value Of A Stock - (The Present Value Of Future Dividends)	Degree Of Total Leverage
Value Of A Stock Based On Constant Growth	Degree Of Total Leverage - If NO Preferred Stock Exists
Approximate Yield To Maturity	Degree Of Total Leverage - If Preferred Stock Exists
Asset Value	Earnings Per Share (Eps)
	New Earnings Per Share Based On Increased Sales (EPS1)
	Currency Conversion Cross Rate

## Marketing Formulas and Graphs

## Total Cost

TC = Total Cost       $TC = F + (V * Q) =$    $F$   $+$   $($    $V$   $*$    $Q$   $) =$

F = Fixed Costs

V = Variable Cost per unit

Q = Quantity of units produced

## Break Even Quantity

$Q_{BE} = F / (P - V) =$    $F$   $/$   $($    $P$   $-$    $V$   $) =$

$Q_{BE}$  = Break Even Quantity

F = Fixed Costs

P = Sales Price of item       $Q_{BE} = F / (\text{Unit Contribution}) =$    $F$   $/$    $\text{Unit Contribution} =$

V = Variable Cost per unit

## Contribution Margin

P = Sales Price of item       $\text{Contribution Margin} = P - V =$    $P$   $-$    $V =$

V = Variable Cost per unit

## Total Contribution

$\text{Total Contribution} = (P - V) * Q$

P = Sales Price of item       $\text{Total Contribution} =$   $($    $P$   $-$    $V$   $) *$    $Q =$

V = Variable Cost per unit

Q = Quantity of units produced

$\text{Total Revenue} =$    $P$   $*$    $Q =$

$\text{Total Variable Cost} =$    $V$   $*$    $Q =$

$\text{Total Contribution} = \text{Total Revenue} - \text{Total Variable Cost} =$    $-$    $=$

## Manufacturer's Margin

$\text{Manufacturer's Margin} =$   $\text{MFR's Selling Price to Distributors} - \text{Manufacturing Cost} =$    $-$    $=$

**Wholesaler's Margin**

$$\begin{array}{rclclcl} & & \text{Wholesaler's Selling} & & & \\ \text{Wholesaler's Margin} & = & \text{Price to Retailers} & - & \text{Price Paid to MFR} & \\ & & \text{[Cyan Box]} & - & \text{[White Box]} & = \text{[Red Box]} \end{array}$$

**Retailer's Margin**

$$\begin{array}{rclclcl} & & \text{Retailer's Selling Price} & & & \\ \text{Retailer's Margin} & = & \text{to Consumer} & - & \text{Price Paid to Wholesaler} & \\ & & \text{[Cyan Box]} & - & \text{[White Box]} & = \text{[Red Box]} \end{array}$$

## Operations Management

### Queueing Theory (Single Server)

#### Probability that No Customers are in System

$$P_0 = 1 - (\lambda / \mu)$$

$P_0$  = Probability that No Customers are in System

$\lambda$  = Mean Arrival Rate

$\mu$  = Mean Service Rate

$$P_0 = 1 - \left( \frac{\lambda}{\mu} \right) = \boxed{\phantom{000}}$$

#### Probability that the Server is Busy (there are customers)

$\rho$  = Probability that the Server is Busy (there are customers)

$\lambda$  = Mean Arrival Rate

$\mu$  = Mean Service Rate

$$\rho = \lambda / \mu = \frac{\lambda}{\mu} = \boxed{\phantom{000}}$$

#### Probability that exactly $n$ Customers are in System

$$P_n = \{ 1 - (\lambda / \mu) \} * \{ (\lambda / \mu)^n \}$$

$P_n$  = Probability that  $n$  Customers are in System

$\lambda$  = Mean Arrival Rate

$\mu$  = Mean Service Rate

$n$  = Number of Customers

$$P_n = \{ 1 - \left( \frac{\lambda}{\mu} \right) \} * \left( \frac{\lambda}{\mu} \right)^n = \boxed{\phantom{000}}$$

#### Average Number of Customers in the System

$$L = \lambda / (\mu - \lambda)$$

$L$  = Average Number of Customers in the System

$\lambda$  = Mean Arrival Rate

$\mu$  = Mean Service Rate

$$L = \frac{\lambda}{\mu - \lambda} = \boxed{\phantom{000}}$$

#### Average Number of Customers in Queue

$$L_q = \lambda^2 / (\mu (\mu - \lambda))$$

$L_q$  = Average Number of Customers in the Queue

$$L_q = \frac{\lambda^2}{\mu (\mu - \lambda)} = \boxed{\phantom{000}}$$

$\lambda$  = Mean Arrival Rate $\mu$  = Mean Service Rate

$$\frac{\mu}{\mu - \lambda}$$

**Average Time that a Customer spends in System**

W = Average Time that a Customer spends in System

 $\lambda$  = Mean Arrival Rate $\mu$  = Mean Service Rate

$$W = 1 / (\mu - \lambda) = \frac{1}{\mu - \lambda} = \boxed{\phantom{000}}$$

**Average Time that a Customer spends in Queue** $W_q$  = Average Time that a Customer spends in Queue $\lambda$  = Mean Arrival Rate $\mu$  = Mean Service Rate

$$W_q = \frac{\lambda}{\mu * (\mu - \lambda)} = \boxed{\phantom{000}}$$

**Economic Analysis**

$$TC = (C_w * L) + C_s$$

TC = Total Cost

 $C_w$  = Waiting Cost per Customer (Opportunity Cost)

L = Average Number of Customers in the System

 $C_s$  = Service Cost (wages, operating cost...)

$$TC = (C_w * L) + C_s = \boxed{\phantom{000}}$$

**Queueing Theory (Single Server)**Mean Arrival Rate =  $\lambda$ Mean Service Rate =  $\mu$ 

Number of Customers = n

Waiting Cost per Customer (Opportunity Cost) =  $C_w$ Service Cost (wages, operating cost...) =  $C_s$ Probability that No Customers are in System =  $P_0$ Probability that n Customers are in System =  $P_n$ Probability that the Server is Busy (there are customers) =  $\rho$ 

Average Number of Customers in the System = L

Average Number of Customers in the Queue =  $L_q$



Average Time that a Customer spends in System =  $W$ Average Time that a Customer spends in Queue =  $W_q$ Total Cost =  $TC$ 

**The Operations Management Formulas spreadsheet available for purchase at [www.fastformulas.com](http://www.fastformulas.com) includes the following operations management formulas and analyses:**

**Inventory Management**

Average Inventory

Economic Order Quantity

Reorder Point

Total Carrying Cost

Total Inventory Cost

Total Ordering Cost

**Queueing Theory (Single Server)**

Average Number of Customers in Queue

Average Number of Customers in the System

Average Time that a Customer spends in Queue

Average Time that a Customer spends in System

Economic Analysis

Probability that exactly  $n$  Customers are in System

Probability that No Customers are in System

Probability that the Server is Busy (there are customers)

**Queueing Theory (Multiple Servers)**

Average Number of Customers in Queue

Average Number of Customers in the System

Average Time that a Customer spends in Queue

Average Time that a Customer spends in System

Economic Analysis

Probability that an Arriving Customer Must Wait

Probability that exactly  $n$  Customers are in System

Probability that No Customers are in System

Probability that the Server is Busy (there are customers)

## Engineering Economics

## Present Worth Method

P = Present Worth

F = Future Worth

 $i$  = interest rate $n$  = number of periods (years)

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

Option 1

P	F	$i$	$n$	=	
---	---	-----	-----	---	--

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

Option 2

P	F	$i$	$n$	=	
---	---	-----	-----	---	--

The best option is by \_

## Capitalized Cost Method (Infinite life)

C = Initial Cost

EAA = Equal Annual Amount

(Yearly Maintenance Cost)

 $i$  = interest rate

$$\text{Capitalized Cost} = C + \frac{\text{EAA}}{i}$$

C	EAA	$i$	=	
---	-----	-----	---	--

## Annualized Cost Method

C = Initial Cost

 $N_L$  = Periods (Duration or Life)

EAA = Equal Annual Amount

(Yearly Maintenance Cost)

 $i$  = interest rate

Option 1

C	EAA	$N_L$	$i$	=	
---	-----	-------	-----	---	--

Option 2

C	EAA	$N_L$	$i$	=	
---	-----	-------	-----	---	--

The best option is by \_

## Cost / Benefit Ratio

 $ic$  = initial cost $m$  = cost of maintenance

$$B/C = b / (ic + m + v_f)$$

$b$	=	
-----	---	--

$b$  = user benefits

B/C

=

 $ic$  $m$  $v_r$  $v_r$  = residual value

--	--	--

**The Engineering Economics Formulas spreadsheet available for purchase at  
www.fastformulas.com includes the following economics formulas and analyses:**

Bond Present Worth	Return On Total Assets
Effective Annual Rate	Times-Interest-Earned Financial Ratio
Exponential Gradient Cash Flow	Total Assets Turnover Financial Ratio
Investment Doubling Time	Annualized Cost Method
Investment Tripling Time	Capitalized Cost Method
Single - Payment Equivalence	Present Worth Method
Discrete Compounding Conversions	Cost / Benefit Ratio
Average Sales Per Day	Constant Percentage Depreciation Method
Cash Flow Coverage Financial Ratio	Double Declining Balance Depreciation Method
Current Financial Ratio	Production Or Service Output Depreciation Method
Days Sales Outstanding	Sinking Fund Depreciation Method
Debt Financial Ratio	Straight Line Depreciation Method
Earnings Per Share	Sum-Of-The-Years' Digits Depreciation Method
Fixed Assets Turnover Financial Ratio	Double Declining Balance Book Value Method
Inventory Turnover Financial Ratio	Straight Line Book Value Method
Market / Book Financial Ratio	Sum-Of-The-Years' Digits Book Value Method
Price / Earnings Financial Ratio	Direct Reduction Loans
Profit Margin On Sales	Loans With Constant Amount Paid Towards Principle
Quick Financial Ratio Or Acid Test Financial Ratio	Simple Interest Loan
Return On Common Equity	Economic Order Quantity
	Payback Period

## Electrical Engineering (AC Circuits)

### Ideal Transformer - Turns Ratio

$a$  = Turns Ratio

$N_p$  = Primary Number of Turns

$N_s$  = Secondary Number of Turns

$V_p$  = Primary Voltage

$V_s$  = Secondary Voltage

$I_p$  = Primary Current

$I_s$  = Secondary Current

$Z_p$  = Primary Impedance

$Z_s$  = Secondary Impedance

$L_p$  = Primary Leakage Flux

$L_s$  = Secondary Leakage Flux

$$a = N_p / N_s = \frac{N_p}{N_s} = a$$

$$= \frac{N_p}{N_s}$$

$$a = V_p / V_s = \frac{V_p}{V_s} = a$$

$$= \frac{V_p}{V_s}$$

$$a = I_s / I_p = \frac{I_s}{I_p} = a$$

$$= \frac{I_s}{I_p}$$

$$a = \sqrt{Z_p / Z_s} = \frac{Z_p}{Z_s} = a$$

$$= \sqrt{\frac{Z_p}{Z_s}}$$

$$a = \sqrt{L_p / L_s} = \frac{L_p}{L_s} = a$$

$$= \sqrt{\frac{L_p}{L_s}}$$

**Ideal Transformer - Secondary Current**

$$I_s = V_s / Z_s = \frac{V_s}{Z_s} = I_s$$

$I_s$  = Secondary Current  
 $V_s$  = Secondary Voltage  
 $Z_s$  = Secondary Impedance

**Ideal Transformer - Effective Primary Impedance**

$$Z_{ep} = V_p / I_p = \frac{V_p}{I_p} = Z_{ep}$$

$Z_{ep}$  = Effective Primary Impedance  
 $V_p$  = Primary Voltage  
 $I_p$  = Primary Current

$$Z_s = \text{Secondary Impedance} \quad Z_{ep} = Z_p + a^2 * Z_s = \frac{Z_p}{1} + a^2 * Z_s = Z_{ep}$$

$R_p$  = Primary Resistance  
 $R_s$  = Secondary Resistance

$$X_p = \text{Primary Reactance} \quad R_p = a^2 * R_s = \frac{a^2}{1} * R_s = R_p$$

$X_s$  = Secondary Reactance  
 $a$  = Turns Ratio

$$X_p = -a^2 * X_s = \frac{-a^2}{-1} * X_s = X_p$$

## Real Transformers

 $X_p$  = Primary Reactance $X_s$  = Secondary Reactance $\omega$  = Angular Frequency $L_p$  = Primary Leakage Flux $L_s$  = Secondary Leakage Flux $V_{ploss}$  = Primary Voltage Loss $V_{sloss}$  = Secondary Voltage Loss $I_p$  = Primary Current $I_s$  = Secondary Current $f$  = Frequency $\phi_{mloss}$  = Maximum Magnetic Flux Loss $N_p$  = Primary Number of Turns $N_s$  = Secondary Number of Turns

$$X_p = \omega * L_p = \text{[ ]} * \text{[ ]} = \text{[ ]}$$

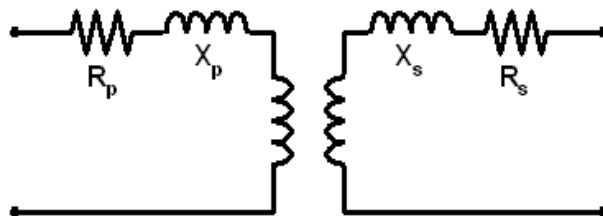
$$X_s = \omega * L_s = \text{[ ]} * \text{[ ]} = \text{[ ]}$$

$$X_p = V_{ploss} / I_p = \text{[ ]} = \text{[ ]}$$

$$X_s = V_{sloss} / I_s = \text{[ ]} = \text{[ ]}$$

$$X_p = 4.44 * f * \phi_{mloss} * N_p / I_p = 4.44 * \text{[ ]} * \text{[ ]} * \frac{\text{[ ]}}{\text{[ ]}} = \text{[ ]}$$

$$X_s = 4.44 * f * \phi_{mloss} * N_s / I_s = 4.44 * \text{[ ]} * \text{[ ]} * \frac{\text{[ ]}}{\text{[ ]}} = \text{[ ]}$$



**Real Transformers - Power Losses**

$P_h = k_h * f * B_m^n = \text{[ ]} * \text{[ ]} * \text{[ ]}^{\text{[ ]}} = \text{[ ]} P_h$   
 $P_e = k_e * f^2 * B_m^2 = \text{[ ]} * \text{[ ]}^2 * \text{[ ]}^2 = \text{[ ]} P_e$   
 $P_{Cu} = I^2 * R = \text{[ ]}^2 * \text{[ ]} = \text{[ ]} P_{Cu}$

$P_h$  = Hysteresis Loss  
 $P_e$  = Eddy-Current Loss  
 $P_{Cu}$  = Copper Loss  
 $k_h$  = Hysteresis Constant  
 $k_e$  = Eddy-Current Constant  
 $f$  = Frequency  
 $B_m$  = Maximum Magnetic Flux Density  
 $n$  = Steinmetz Exponent (usually 1.6)  
 $I$  = Current  
 $R$  = Resistance

**Real Transformers - Transformer Efficiency**

$\eta = P_{out} / P_{in} = \frac{P_{out}}{P_{in}} = \text{[ ]} \eta$   
 $\eta = P_{out} / (P_{out} + P_{los}) = \frac{P_{out}}{P_{out} + P_{los}} = \text{[ ]} \eta$   
 $\eta = 1 - P_{los} / P_{in} = \text{[ ]} P_{los} = \text{[ ]} \eta$

$\eta$  = Efficiency  
 $P_{out}$  = Power Out  
 $P_{in}$  = Power In  
 $P_{los}$  = Power Lost

= 1 -  $\frac{\text{[red box]}}{P_{in} \cdot \text{[red box]}}$  = [red box]

The Electrical Engineering (AC Circuits) Formulas spreadsheet available for purchase at <a href="http://www.fastformulas.com">www.fastformulas.com</a> includes the following electrical engineering formulas and analyses:	
Average Voltage	Energy Stored
Phase Angle Difference	Half-Power Point
Rectangular Voltage	Quality Factor
Voltage	Quality Factor in RLC Parallel Circuit
Voltage Regulation	Quality Factor in RLC Series Circuit
Form Factor	Resonance
Crest Factor	High-Pass Filter Circuit
Impedance in Parallel	Low-Pass Filter Circuit
Impedance in Series	Change in Reactive Power
Impedance Triangle	Complex Power
Reactance	Power Factor
Rectangular Impedance	Power Cost
Admittance	Coefficient of Coupling
Conductance	Induced Voltage
Rectangular Admittance	Magnetic Flux
Rectangular Admittance	Mutual Reactance
Susceptance	Ideal Transformer Effective Primary Impedance
Power	Ideal Transformer Secondary Current
Power in a Resistive Circuit	Ideal Transformer Turns Ratio
Power Stored in a Capacitor	Real Transformer Power Losses
Power Stored in an Inductor	Real Transformer Efficiency
Radiated Power	Two-Port Transformer
Parallel RL Circuit	Transmission Line Characteristic Impedance

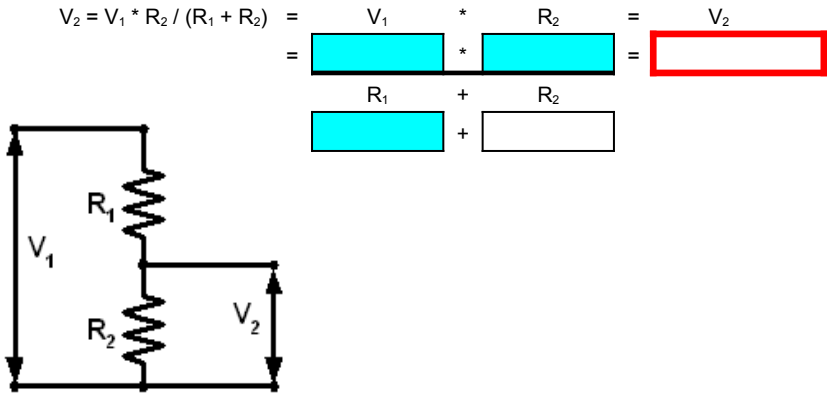


Series RL Circuit	Transmission Line Reflection Coefficient
Parallel RC Circuit	Transmission Line Standing Wave Ratio
Series RC Circuit	Transmission Line Velocity Factor
Parallel RLC Circuit	Gain
Series RLC Circuit	Impedance Model
Bandwidth	Admittance Model
	Hybrid Model

Electrical Engineering (DC Circuits)

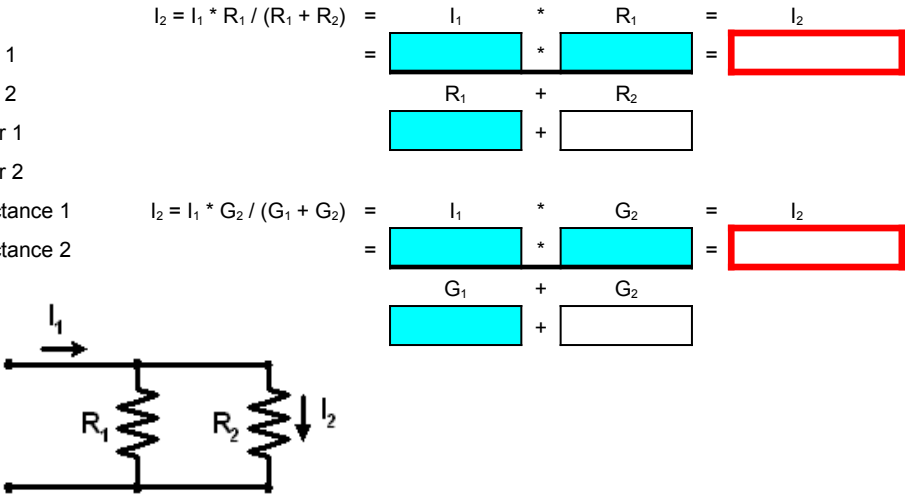
Voltage Divider

- V<sub>1</sub> = Voltage 1
- V<sub>2</sub> = Voltage 2
- R<sub>1</sub> = Resistor 1
- R<sub>2</sub> = Resistor 2

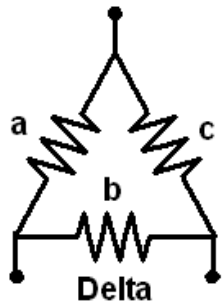
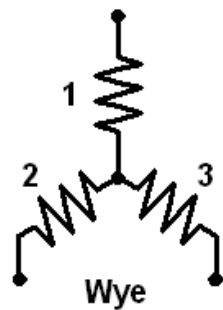


Current Divider

- I<sub>1</sub> = Current 1
- I<sub>2</sub> = Current 2
- R<sub>1</sub> = Resistor 1
- R<sub>2</sub> = Resistor 2
- G<sub>1</sub> = Conductance 1
- G<sub>2</sub> = Conductance 2



## Delta - Wye Transformation

 $R_1$  = Resistor 1 in Wye $R_2$  = Resistor 2 in Wye $R_3$  = Resistor 3 in Wye $R_a$  = Resistor a in Delta $R_b$  = Resistor b in Delta $R_c$  = Resistor c in Delta

$$R_1 = R_a * R_c / (R_a + R_b + R_c) = \frac{R_a * R_c}{R_a + R_b + R_c} = R_1$$

$$R_2 = R_a * R_b / (R_a + R_b + R_c) = \frac{R_a * R_b}{R_a + R_b + R_c} = R_2$$

$$R_3 = R_b * R_c / (R_a + R_b + R_c) = \frac{R_b * R_c}{R_a + R_b + R_c} = R_3$$

$$R_a = R_1 * R_2 / R_3 + R_1 + R_2 = \frac{R_1 * R_2}{R_3} + R_1 + R_2 = R_a$$

$$R_b = R_2 * R_3 / R_1 + R_2 + R_3 = \frac{R_2 * R_3}{R_1} + R_2 + R_3 = R_b$$

$$R_c = R_1 * R_3 / R_2 + R_1 + R_3 = \frac{R_1 * R_3}{R_2} + R_1 + R_3 = R_c$$

**The Electrical Engineering (DC Circuits) Formulas spreadsheet available for purchase at [www.fastformulas.com](http://www.fastformulas.com) includes the following electrical engineering formulas and analyses:**

Area	Conductors in Parallel	Power	Shunt Resistance
Resistance	Conductors in Series	Decibels	Multiplier Resistance
Resistors in Parallel	Thermoelectric Effect	Parallel Circuits	Wheatstone Bridge
Resistors in Series	Voltage	Delta - Wye Transformation	Charging RC Series Circuit
% Conductivity	Voltage in Parallel	Norton Current	Discharging RC Series Circuit
Conductance	Voltage in Series	Thevenin Current	Charging RL Series Circuit
Conductivity	Current Divider	Transfer Resistance	Discharging RL Series Circuit
Voltage Regulation	Voltage Divider	Torque	

## Hydrostatic Forces on a Dam

### Moments Acting on a Gravity Dam

$M_{\text{overturning}}$  = moment (torque) applied to dam by horizontal pressure, causing it to pivot about the heel of the dam

$M_{\text{resisting}}$  = moment (torque) applied to dam by weight of dam and vertical pressure, resisting the overturning moment

$R_x$  = horizontal component of the resultant hydrostatic force upon the dam

$R_y$  = vertical component of the resultant hydrostatic force upon the dam

$y_{Ry}$  = horizontal distance between the heel and the line of action of the force  $R_y$

$y_{Rx}$  = vertical distance between the heel and the line of action of the force  $R_x$

$W$  = weight of dam

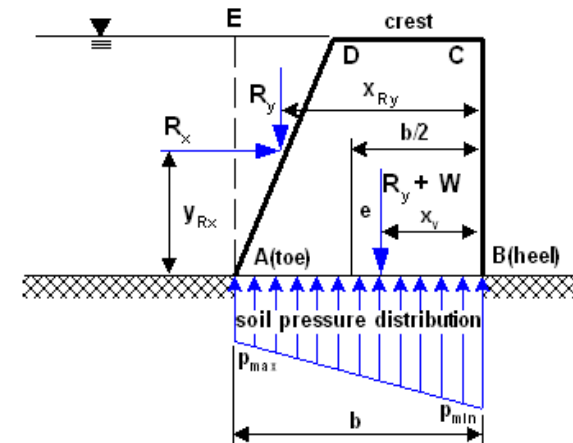
$x_{CG}$  = horizontal distance between the heel and the dam's center of gravity

$(FS)_{\text{overturning}}$  = factor of safety against overturning

$$(FS)_{\text{overturning}} = M_{\text{resisting}} / M_{\text{overturning}} = \frac{M_{\text{resisting}}}{M_{\text{overturning}}} = (FS)_{\text{overturning}}$$

$$M_{\text{overturning}} = R_x * y_{Rx} = \frac{R_x}{1} * \frac{y_{Rx}}{1} = F_{\text{latch}}$$

$$M_{\text{resisting}} = (R_y * y_{Ry}) + (W * x_{CG}) = \left( \frac{R_y}{1} * \frac{y_{Ry}}{1} \right) + \left( \frac{W}{1} * \frac{x_{CG}}{1} \right) = M_{\text{resisting}}$$



Hydrostatic Forces on a Dam

### Lateral Forces Acting on a Gravity Dam

$$F_f = \mu_{\text{static}} * N = \mu_{\text{static}} * N = F_f$$

$F_f$  = frictional force

$\mu_{\text{static}}$  = coefficient of static friction

$N$  = normal force

$W$  = weight of the dam

$$F_f = \mu_{\text{static}} * (W + R_y) = \mu_{\text{static}} * \left( \frac{W}{1} + \frac{R_y}{1} \right) = F_f$$

$(FS)_{\text{sliding}}$  = factor of safety against sliding

$R_y$  = vertical component of the resultant hydrostatic force upon the dam

$R_x$  = horizontal component of the resultant hydrostatic force upon the dam

$$(FS)_{\text{sliding}} = F_f / R_x = \frac{F_f}{R_x} = (FS)_{\text{sliding}}$$

### Soil Pressures

$p_{\text{max}}$  = maximum predicted soil pressure

$p_{\text{min}}$  = minimum predicted soil pressure

$R_y$  = vertical component of the resultant hydrostatic force upon the dam

$W$  = weight of dam

$b$  = width of dam

$e$  = eccentricity, distance between the mid-length of the dam and the line of action for the total vertical force ( $W+R_y$ )

$x_v$  = horizontal distance from the heel to the line of action of the total vertical force ( $W+R_y$ )

$M_{\text{resisting}}$  = moment (torque) applied to dam by weight of dam and vertical pressure, resisting the overturning moment

$$p_{\text{max}} = (R_y + W) / b * (1 + 6 * e / b) = \frac{(R_y + W)}{b} * \left(1 + \frac{6 * e}{b}\right) = p_{\text{max}}$$

$$p_{\text{min}} = (R_y + W) / b * (1 - 6 * e / b) = \frac{(R_y + W)}{b} * \left(1 - \frac{6 * e}{b}\right) = p_{\text{min}}$$

$$e = b / 2 - x_v = \frac{b}{2} - x_v = e$$

$$x_v = M_{\text{resisting}} / (R_y + W) = \frac{M_{\text{resisting}}}{(R_y + W)} = x_v$$

The Mechanical Engineering Fluids Statics Formulas spreadsheet available for purchase at  
www.fastformulas.com includes the following mechanical engineering formulas and analyses:

**Hydrostatic Pressure on Surfaces**

Pressure on an Inclined Plane Surface

Pressure on Curved Surfaces

Pressure on General Plane Surface

Pressure on Horizontal Plane Surfaces

Pressure on Vertical Plane Surfaces

**Hydrostatic Forces on a Dam**

Lateral Forces Acting on a Gravity Dam

Moments Acting on a Gravity Dam

Soil Pressures

**Torque on a Gate****Pressure Due to Several Immiscible Liquids****Manometers**

Monometers Requiring Correction (With Large Fluid Column Height, or High-Density Fluid Surrounding Manometer Fluid)

Standard Manometers ( For Use with Small Fluid Column Height)

**Fluid Height and Pressure**

Pressure in Multi-Fluid Barometers or Vessels

Pressure Reading from Barometers, Including Vapor Pressure

Pressure Reading from Barometers, Neglecting Vapor Pressure

Pressure vs. Height

## Capillary Action

### Height of Liquid in a Capillary Tube

$$h = (4 \cdot \sigma \cdot g_c \cdot \cos \beta) / (\rho \cdot d_{\text{tube}} \cdot g) = \left( \frac{4}{4} \cdot \sigma \cdot g_c \cdot \cos \beta \right) / \left( \rho \cdot d_{\text{tube}} \cdot g \right) = \sigma$$

$h$  = height of liquid in capillary tube (relative to liquid surface outside tube)

$\sigma$  = surface tension

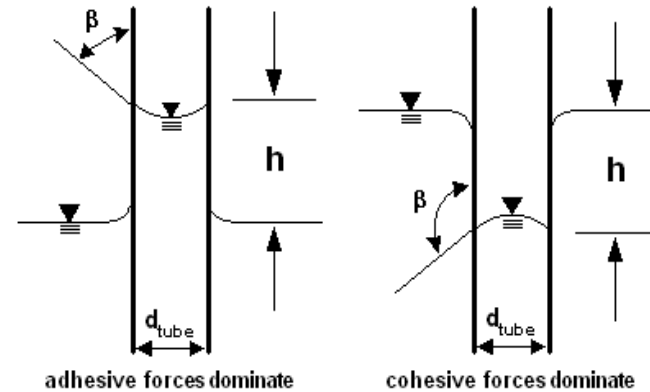
$\beta$  = contact angle, in RADIANS

$g_c$  = gravitational conversion constant: For SI,  $g_c=1$ , for English,  $g_c=32.174$

$\rho$  = density

$d_{\text{tube}}$  = diameter of tube

$g$  = gravitational acceleration



### Capilarity of Liquids

### Surface tension in a Capillary Tube

$$\sigma = (h \cdot \rho \cdot d_{\text{tube}} \cdot g) / (4 \cdot \cos \beta \cdot g_c) = \left( h \cdot \rho \cdot d_{\text{tube}} \cdot g \right) / \left( 4 \cdot \cos \beta \cdot g_c \right) = \sigma$$

$h$  = height of liquid in capillary tube (relative to liquid surface outside tube)

$\sigma$  = surface tension

$\beta$  = contact angle, in RADIANS

$g_c$  = gravitational conversion constant: For SI,  $g_c=1$ , for English,  $g_c=32.174$

$\rho$  = density

$d_{\text{tube}}$  = diameter of tube

$g$  = gravitational acceleration

### Radius of the Meniscus



$$r_{\text{meniscus}} = d_{\text{tube}} / (2 * \cos(\beta)) = \frac{d_{\text{tube}}}{2 * \cos(\beta)} = r_{\text{meniscus}}$$

$r_{\text{meniscus}}$  = radius of the meniscus

$d_{\text{tube}}$  = diameter of the tube

$\beta$  = contact angle, in RADIANS

**The Mechanical Engineering Fluids Properties Formulas spreadsheet available for purchase at [www.fastformulas.com](http://www.fastformulas.com) includes the following mechanical engineering formulas and analyses:**

### **Mole Fractions**

### **Kinematic Viscosity**

### **Osmotic Pressure**

### **Fluid Pressure and Vacuum**

Absolute Pressure

Fluid Pressure

### **Mass & Density**

API Hydrometer Scale

Baume' Hydrometer Scale

Density: Slugs vs.  $\text{Lb}_m$

Ideal Gas Law

Specific Gravity of a Gas: Equivalent Ratios

Specific Gravity of a Liquid

Specific Volume

Specific Weight of a Fluid

### **Shear Stress**

Proportionality of Pressure to Rate of Strain

Fluid Shear Stress

### **Surface Tension**

Bubble

Droplet

Ring

Two-sided Rectangular Film

### **Capillary Action**

Height of Liquid in a Capillary Tube

Radius of the Meniscus

Surface tension in a Capillary Tube

### **Compressibility**

Coefficient of Compressibility

Compressibility for Adiabatic Ideal Gas Processes

Compressibility for Isothermal Ideal Gas Processes

Compressibility in Terms of Partial Derivatives

Density of a Compressible Fluid

### **Bulk Modulus**

Secant Bulk Modulus

Tangent (or Point) Bulk Modulus

Bulk Modulus and Compressibility

### **Speed of Sound**

Mach Number of an Object

Speed of Sound Due to Temperature Change

Speed of Sound for a Liquid

Speed of Sound for an Ideal Gas