

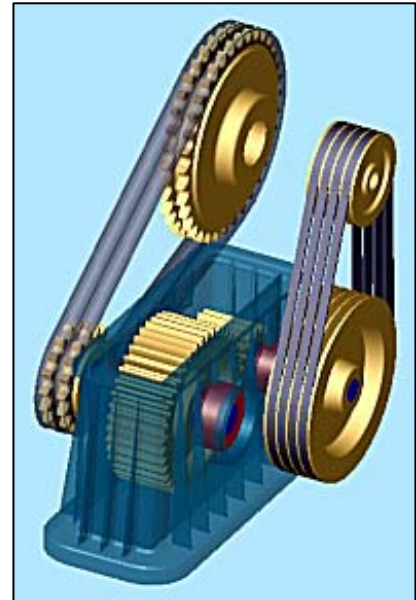
# MITCalc for Pro/ENGINEER

## MITCalc

MITCalc is a multi-language set of mechanical, industrial and technical calculations for the day-to-day routines. It will reliably, precisely, and most of all quickly guide customer through the design of components, the solution of a technical problem, or a calculation of an engineering point without any significant need for expert knowledge.

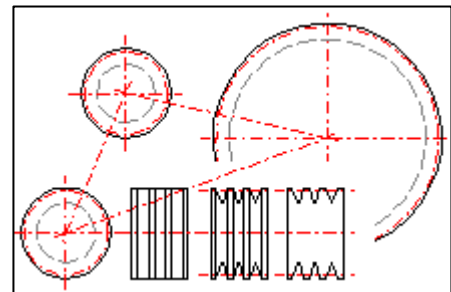
MITCalc contains both design and check calculations of many common tasks, such as: tooth, belt, and chain gear, beam, shaft, springs, bolt connection, shaft connection and many others. There are also many material, comparison, and decision tables, including a system for the administration of resolved tasks. The calculations support both Imperial and Metric units and are processed according to ANSI, ISO, DIN, BS, CSN and Japanese standards.

It is an open system designed in Microsoft Excel, which allows not only easy user-defined modifications and user extensions without any programming skills, but also mutual interconnection of the calculations, which is unique in the development of tailor-made complex calculations. The sophisticated interaction with Pro/ENGINEER allows 3D models to be inserted very quickly.

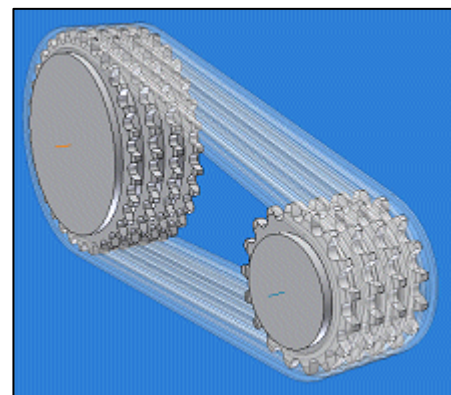


**MITCalc for Pro/ENGINEER** is installed in form of individually installed plug-ins containing relevant parametric models and an interface between Excel and Pro/ENGINEER.

**MITCalc for Pro/ENGINEER** cooperates with Pro/ENGINEER inserting adequate 3D models and their assemblies in seconds. An assembly may consist of not only individual components but also groups of components (sub-assemblies). You can insert one complete solution of a belt gear at once, which is fully associative, and the dimensions of the inserted component (sub-assembly) will change automatically in case you make changes to the calculation parameters later.



**MITCalc for Pro/ENGINEER** installation packages (15-day trial version) are available at [www.cogras.cz](http://www.cogras.cz).



## User interface

Most of the calculations have a similar user interface the main advantage of which is its top-to-bottom layout – every task flows logically from an assignment to the results. In other words, the structure of a calculation is like what you are already accustomed to when solving the same task with a calculator and sheet of paper. Other advantages of our solution are:

- The “Expert Notes” system containing recommendations and tips for input and output values [1].
- Support of standard and imperial units [2].
- Recommended values – the calculation “knows” how to set (estimate) the right coefficients [3].
- Any change of parameters immediately results in recalculation of the entire task (a table).
- For most of the calculations, there is the “Automatic Design” mode available, which offers a set of solutions based on minimum input information and one parameter to optimize (e.g. weight, safety, dimensions) [4].

**Synchronous belts**

	Pulley 1	Pulley 2	
1.1 Calculation units	Imperial (lbf, in, HP...)		
1.2 Transferred power	P 2.70	2.65	[HP]
1.3 Pulley speed (desired)	n 2000	800	[/min]
1.4 Pulley speed (actual)	n 2000.0	833.3	[/min]
1.5 Pulley diameter	i 2.500	2.400	
1.6 Torque	Mk 85.05	200.04	[lb.ft]
1.7 The manner of loading	B...Moderate shocks		
1.8 The manner of loading	C...Light duty		
1.9 Daily operating hours	A...Less than 8 hours		
1.10 Coefficient of safety	c2 1.4	1.4	[%]
1.11 Efficiency	eta 98		

**2.0 Automatic design**

**3.0 Design and calculation**

**4.0 Results, coefficients**

**5.0 Dimensions of the pulley and belt**

**6.0 Graphic output, CAD systems**

6.1 2D drawing output to: DXF File

6.2 2D drawing scale: Automatic

6.3 Detail: Pulley 1

## Why MS Excel is used?

The history of table calculators began in the 1980's (1979 - Visicalc) and their use has considerably expanded since. Though, at the beginning, these calculators were used mostly in the field of economics, statistics and financial calculations, their use is more or less universal today and there probably aren't any technical workers who have no experience with a table calculator.

Microsoft Excel is obviously the best product. This program provides a wide scope of options and user modifications (control elements, programming language, table formatting, etc). This

predestinates it for use in engineering, industrial and technical calculations with the following main benefits.

- General knowledge of Excel, millions of users, multi-platform applications (Windows, Apple).
- User's interface - Excel enables to design a natural user environment for this type of task.
- Open solution - The user can simply modify or extend the calculation according to their own requirements and usage.
- Complex solution - Interconnection of several calculations (even including separate tables) allows quick preparation of a solution for complex entries - tailored solution.
- Data sharing - A range of programs (including many CAD systems) can cooperate with Excel tables directly.
- Communication - Simple data transfer - sending a workbook also includes sending the data and procedure.
- Publication activity - easy publication of results on the Internet or Intranet, and simple modifications of print reports
- .....and many others.

## Individual modules description

Detailed information about all calculations, used standards, tables, and tools are available in comprehensive documentation, which is accessible once the MITCalc application is installed (with a 30-day-testing period available). Some brief information about individual modules is available below.



### MITCalc - Beam

The application is designed for calculations of straight, maximum three times static indefinite beams with constant axis-symmetrical profiles.

- Simple definition of the type of beam and its loading with visual check.
- Calculation of area characteristics of 20 types of cross sections.
- Calculation of reactions in supports.
- Calculation of minimum / maximum bending moment, stress and deflection of the beam.
- Calculation and graphic illustration of the moment, stress, deflection and bending angle of the loaded beam.

The application includes a table of materials and a table of area characteristics of W, S, C, L profiles acc. to ANSI/AISC and I, U, L a T profiles acc. to DIN/ISO. Used standards: DIN 1025, 1026, 1028, 1029, 1024, AISC W, S, C, L, LU



### MITCalc - Shaft

The calculation is designed for geometrical design and complex strength check of shafts.

- Simple definition of installed shafts, including hollow ones.
- Options of definitions of necking-down, recesses, grooves and calculation of the relevant coefficients of stress concentration.
- Simple definition of spatial shaft load.
- Calculation of reactions, courses of forces, moments, stress, deflection and bending angle of the shaft and others.
- Calculation of critical speed and safety coefficients.

The calculation is based on data, procedures, algorithms and data from specialized literature and standards AGMA, ISO, DIN and BS. List of standards (DIN 743).



### MITCalc - Profiles

The calculation solves area characteristics of profiles created in a simple graphic editor and mass characteristics of solids created by extrusion or rotation of the profile.

- Creation of a profile in a simple graphic editor.
- Calculation of area characteristics ( $I_x$ ,  $S_x$ ) for main axes passing through the centre of gravity.
- Calculation of area characteristics ( $I_x$ ,  $S_x$ ) for randomly turned axes passing through the centre of gravity, including a graph.
- Calculation of characteristics for the turned axes which pass through a random point.
- Calculation of volume and mass characteristics ( $V$ ,  $m$ ,  $I_m$ ) of solids created by extrusion or rotation of the profile.



## MITCalc - Slender strut buckling

The program is designed to calculate the optimum cross-section and perform strength check of slender struts strained for buckling. The program includes:

- Selection of six basic types of buckling.
- Calculation of area characteristics of 20 types of cross-sections.
- Design of optimum profile accommodating the set load.
- Strength check of the strut.
- Calculation and graphical representation of permitted stress dependent on slenderness rate.
- A table of materials and a table of area characteristics of W, S, C and L profiles according to ANSI/AISC and I, U, L and T profiles according to DIN/ISO.

The calculation is based on data, procedures, algorithms (Johnson, Tetmajer, Euler, Secant) and data from specialized literature and AISC, ISO, DIN and BS standards.

List of standards (DIN 1025, 1026, 1028, 1029, 1024, AISC W, S, C, L, LU ... )



## MITCalc - Spur Gearing

Geometric design and strength check of spur gearing with straight and helical toothing.

- Calculation of helical and straight toothing.
- Automatic design of a transmission with the minimum number of input requirements.
- Design for entered coefficients of safety (static, dynamic).
- Calculation of complete geometric parameters (including corrected toothing).
- Calculation of strength parameters, safety check.
- Design of gearing for exact axis distance.
- Supplementary calculations (calculation of parameters of the existing gear, temperature rise, design of shafts)
- Optimization of parameters (dimensions, weight, volume, transmission ratio)

The calculations use procedures, algorithms and data from standards ANSI, ISO, DIN, BS and specialized literature.

Used standards: ISO 6336, ISO 1328, DIN 3990, ANSI B6.1-1968, AGMA 2001-C95, AGMA 908-B89/95 and others.



## MITCalc - Bevel gear

The calculation is designed for geometric and strength designs and checks of bevel gear with straight, helical and curved teeth. The programme gives solutions to the following tasks:

- Calculation of helical and straight toothing.
- Automatic design of a transmission with the minimum number of input requirements.
- Design for entered coefficients of safety (static, dynamic).
- Calculation of complete geometric parameters (including corrected toothing).
- Calculation of strength parameters, safety check.
- Supplementary calculations (calculation of parameters of the existing gear, temperature rise, design of shafts)

The calculations use procedures, algorithms and data from standards ANSI, ISO, DIN, BS and specialized literature.

Used standards: DIN 3971, DIN 3991 Kegelnradern 1-4, ISO 6336 1-3, DIN 3965 Toleranzen für Kegelnradverzahnungen 1-4, ISO 1328, DIN 3990, ANSI B6.1-1968, AGMA 2001-C95, AGMA 908-B89/95, AGMA 2003-A86/88, AGMA 2005-B88 and others.



## MITCalc - Auxiliary calculations of gearing

This workbook includes two auxiliary calculations to calculations of gearing.

- Optimizing of parameters (dimensions, weight, volume) through distribution of the total transmission ratio "i" to individual pairs of gears with double reduction or triple reduction gearbox with spur gears.
- Optimizing of the number of teeth of gears to achieve an exact total transmission ratio "i" with single, double and triple reduction transmissions (toothed wheels, toothed belts, chains)



## MITCalc - Rolling bearings

This document can be used for the selection, calculation and check of rolling bearings of the company SKF. The programme provides solutions to the following tasks:

- Selection and check of a suitable bearing. The document includes a database of approx. 10,000 different rolling bearings SKF in all basic types and design.
- Calculation of basic bearing parameters (life, static safety, etc.).
- Calculation of adjusted bearing life acc. to the new methodology of ISO 281.
- Calculation of load with a pair of tapered roller bearings or a pair angular contact ball bearings resp.

- Support of 2D and 3D CAD systems.

In addition to the above given basic calculations, the document also includes several other auxiliary calculations (e.g. a calculation of lubricant operational viscosity, calculation of mean loads for bearings loaded by variable loads, calculation of permitted bearing speed, etc.). The programme uses data, procedures, algorithms and other information from specialised literature, catalogues of rolling bearings SKF, ISO, ANSI, SAE standards and other sources.

## MITCalc - V-Belts

The calculation is designed for a geometrical design and strength check of belt transmissions using V-belts.

- Calculation for 2 or 3 pulleys.
- Automatic design of a transmission with the minimum of input requirements.
- Design and calculation of geometrical parameters (diameters of pulleys, axis distances, length of the belt, weight of the transmission)
- Calculation of strength parameters (power transferred by the belt, number of belts, efficiency, etc.)
- Calculation of force conditions (prestressing, axis loading of the pulleys, etc.)

The calculations use procedures, algorithms and data from basic documents and standards ANSI, RMA (Rubber Manufacturers Association), ISO, DIN, BS, and basic documents from catalogues of companies CONTITECH (r) and Gates Rubber Company (r).

Used standards: Narrow V-Belts ANSI/RMA IP-22; Traditional V-Belts ANSI/RMA IP-20; Light Duty V-Belts ANSI/RMA IP-23; DIN 7753; DIN 2211; DIN 2215; ISO 4184

## MITCalc - Timing Belts

The calculation is designed for a geometrical design and strength check of toothed belt transmissions.

- Selection of the type of belt with a suitable output power.
- Selection of an optimum transmission alternative in view of power, geometry and weight.
- Option of designing a non-standard transmission.
- Calculation of all necessary strength and geometrical parameters.
- Calculation of power parameters and axis loads.

The calculations use procedures, algorithms and data from ANSI, RMA (Rubber Manufacturers Association), ISO, DIN, BS and basic documents from catalogues of companies ContiTech(r) and Gates Rubber Company(r). The database of belts includes the 20 most frequently used types of toothed belts.

Used standards: Synchronous Belts ANSI/RMA IP-24, 1983; DIN 7721; DIN ISO 5296; ISO 5295; ISO 5294

## MITCalc - Roller Chains

The calculation is designed for a geometrical design and strength check of common chain transmissions using roller chains.

- Selection of a power suitable type of chain.
- Selection of an optimum transmission alternative regarding power, geometry and weight.
- Calculation of geometric, strength, safety and operational parameters.
- Calculation of power parameters and axis loads.

The application includes corresponding databases of roller chains. The calculations use data, procedures, algorithms and data from ANSI/ASME, ACA (American Chain Association) ISO, DIN, BS and JIS.

Used standards: ANSI/ASME B29.1M (Dec2001), ANSI/ASME B29.3, DIN 8187, DIN 8181, DIN 8181, DIN 8164, DIN 8150, ISO R606, ISO 1275, BS 228, JIS B1801, JIS B1803.

## MITCalc - Multi-pulley

The calculation is developed for geometrical designs of belt and chain transmissions with more sprocket wheels (max. 15).

- Calculation of the necessary length of the belt (chain) using known positions and diameters of sprocket wheels
- Achieving the desired (table) length of the belt / chain using a change in the position of the selected sprocket wheel.
- Calculation of geometry (angles of wrapping, numbers of teeth in engagement, axis distances, etc.)
- Calculation of the radial force acting on the sprocket wheel axis.

## MITCalc - Bolted connection

The calculation is designed for a geometrical design and strength check of a prestressed bolt connection, loaded by static or cyclic loading resp., acting both in the axis of the bolt and in the plane of the connected parts.

- Automatic design of a connection bolt of standard design.
  - Calculation and check of connections fitted with special shanks.
  - Design and calculation of necessary mounting prestressing of the connection and fastening torque.
  - Calculation of force conditions of a loaded connection.
  - Static and dynamic strength check.
  - The application includes a table of commonly used materials of bolts according to ISO, SAE and ASTM, and a selection of materials of the connected parts according to AISI/SAE, DIN, BS, AF and others.
- The calculations use data, procedures, algorithms and data from specialized literature and standards ANSI, ISO, DIN.  
Used standards: ANSI B1.1, ANSI 273, ANSI B18.2.1, ANSI B18.2.2, ANSI B18.3, ANSI B18.6.2, ANSI B18.6.3, ANSI B18.22.1, ISO 273, ISO 1207, ISO 4016, ISO 4032, ISO 4035, ISO 4762, ISO 8738, VDI 2230



## MITCalc - Shaft Connection

Geometric designs and strength checks of shaped connections of shafts with hubs.

- Design of a connection with parallel side keys.
- Design of a connection with Woodruff's keys.
- Design of a connection with straight-sided splines.
- Design of a connection with involute splines.
- Strength check of designed couplings.
- The application includes a table of keys and splines according to ISO, SAE, DIN, BS, JIS and CSN.

Used standards: ANSI B17.1, ANSI B17.2, ANSI B92.1, ANSI B92.2M, ISO R773, ISO 14, ISO 4156, DIN 6885, DIN 6888, DIN 5464, DIN 5471, DIN 5472, DIN 5480, BS 4235, BS 6, JIS B 1301, CSN 02 2562, CSN 30 1385, CSN 01 4942, CSN 4950



## MITCalc - Force couplings of shafts with hubs

The calculation is intended for geometrical design and strength check of force couplings of shafts with hubs with a cylindrical contact area. The application provides solutions for the following tasks:

- Design of force fits, possibly shrink fits.
- Design of clamping connections with separated, or one-side cut hub.
- Strength check of designed couplings.
- Check of interference fit strained by additional radial force with bending moment.
- Check of interference fit working at specific service temperature.

The calculation is based on data, procedures and algorithms from specialized literature and standards ANSI, ISO, DIN and others.

List of standards: ANSI B4.1, ISO 286, DIN 7190



## MITCalc - Compression Springs

The calculation is intended for the purposes of geometric and strength designs of helical compression cylindrical springs made of wires and rods of circular sections, cold formed, loaded with static or fatigue loading.

- Automatic design of a spring.
- Selection of an optimal alternative of spring design in view of strength, geometry and weight.
- Static and dynamic strength check.
- Calculation of working forces of a spring of known production and installation dimensions.
- Calculation of installation dimensions for known loading and production parameters of the spring.
- The application includes a table of commonly used spring materials according to ISO, ASTM/SAE, DIN, BS, JIS and others.

The calculation is based on data, procedures, algorithms and data from specialized literature and standards EN 13906-1, DIN 2089-1, DIN 2095.



## MITCalc - Tension Springs

The calculation is intended for the purposes of geometric and strength designs of helical tension cylindrical springs made of wires and rods of circular sections, cold formed, loaded with static loading.

- Automatic design of the spring.
- Selection of an optimal alternative of the spring design in view of strength, geometry and weight.
- Strength check of the spring.
- Calculation of working forces of a spring of known production and mounting dimensions.
- Calculation of mounting dimensions for a known loading and production parameters of the spring.

- The application includes a table of commonly used spring materials according to ISO, ASTM/SAE, DIN, BS, JIS and others.

The calculation is based on data, procedures and algorithms from specialized literature and standards EN 13906-2, DIN 2089-2, DIN 2097.



## MITCalc - Torsion Springs

The calculation is intended for the purposes of geometric and strength designs of spiral cylindrical torsion springs made of wires and rods in circular sections, cold formed, loaded with a static or cyclic loading.

- Automatic design of the spring.
- Selection of the optimal design of the spring with respect to strength, geometry and weight.
- Static and dynamic strength tests.
- Calculation of the working forces of a spring with known production and mounting dimensions.
- Calculation of mounting dimensions for known spring loading and production parameters.
- The application includes a table of commonly used spring materials according to ISO, ASTM/SAE, DIN, BS, JIS and others.

The calculation is based on data, procedures and algorithms from specialized literature and the standards EN 13906-2, and DIN 2088.



## MITCalc - Tolerances

This calculation includes tables and calculations for easy option of fits of machine parts and determination of their dimensional tolerances and deviations.

- Selection of suitable fits of machine parts according to the international standard ISO 286.
- Determination of dimensional tolerances and deviations of machine parts according to the international standard ISO 286.
- Selection of preferred fits of machine parts and determination of their dimensional tolerances and deviations according to ANSI B4.1.
- Determination of non-prescribed limit deviations of linear and angular dimensions according to ISO 2768.
- Automatic design of a fit for the given clearance or fit interference respectively.

The data, procedures, algorithms and specialized literature and standards ANSI, ISO, DIN and others were used in the calculations.

Used standards: ANSI B4.1, ANSI B4.2, ISO 286, ISO 1829, ISO 2768, EN 20286, JIS B0401



## MITCalc - Tolerance Analysis

Two programs are available for the analysis of linear, 2D and 3D dimensional chains, which in addition to the basic analysis (Worst case, Root Sum Squares, Monte Carlo...) also include a solution to some special matters, like analysis of a dimensional chain deformed as a result of temperature change and design of tolerances for a selective assembly.

### **Tolerance analysis of linear dimensional chains.**

The program is designed for tolerance analysis of linear (1D) dimensional chains. The program solves the following problems:

- Tolerance analysis, synthesis and optimization of a dimensional chain using the arithmetic "WC" (Worst case) method, possibly the statistical "RSS" (Root Sum Squares) method.
- Analysis of a dimensional chain deformed as a result of temperature change.
- Extended statistic analysis of dimensional chain using the "6 Sigma" method.

Tolerance analysis of a dimensional chain during selective assembly including optimization of the number of assembled products.

All solved tasks enable work with standardized tolerance values, both in designing and in optimization of the dimensional chain.

### **Tolerance analysis of 2-D and 3-D dimensional chains.**

The program is designed for the tolerance analysis of two-dimensional (2-D) and three-dimensional (3-D) dimensional chains. The program solves the following problems:

- Tolerance analysis of a dimensional chain using the "Worst case" method.
- Tolerance analysis of a dimensional chain using the "Monte Carlo" method.

In designing a dimensional chain, the program enables work with standardized tolerance values.

Data, methods, algorithms and information from professional literature and ANSI, ISO, DIN and other standards are used in calculation. List of standards: ANSI B4.1, ISO 286, ISO 2768, DIN 7186

## MITCalc - Conversion of units, tables

In addition to all the calculations, MITCalc also contains many comparison and conversion tables.

- Conversion of units. This table allows conversion of various units from various unit systems. It also allows conversions of a gearing (module, pitch, mm, inches), roughness, and material hardness conversions and material strengths.
- Tables of safety coefficients. Some commonly used theories and tables for determination of safety coefficients corresponding to certain design conditions.
- Comparison table of transmissions. Self-contained information allowing quick selection of a suitable and optimal type of a transmission with constant transmission ratio.
- Comparison table of shaft connections. When selecting a shaft connection type with a hub, this table may be very useful. It compares basic properties of particular connection types.

## MITCalc - Technical Formulas

Excel workbook contains solutions to dozens of basic formulas from physics, technology and mechanical engineering. Help, pictures as well as many selection tables with values of various coefficients and material properties are available for the formulas. The following matters are solved in the workbook:

- Characteristics of solids (volume, surface, weight, inertia moment)
- Rectilinear motion (speed, acceleration, trajectory, time, force, energy....)
- Rotation motion (speed, acceleration, trajectory, time, force, energy....)
- Thermal expansion (longitudinal, cubical)
- Friction (shear, rolling, journal, rope, belt)
- Design of engine capacity (pump, blower, hoist, crane)

## MITCalc – Project, Searching of calculation

Most of the calculations include a uniform header that:

- Unifies the appearance and improves the orientation in printed outputs.
- Maintains uniform information on the performed calculations and enables their effective management.
- Enables fast retrieval of any calculation (project) using the delivered tool "Search calculation".

### Searching of calculation

In case of more intensive use of calculations the volume of \*.xls calculation files with various alternatives of solutions or files determined for various project will be increasing. This tool is determined for simple retrieval of a calculation and easy orientation among the calculation \*.xls files and enables:

- Searching through the complete directory structure including hidden sub-directories.
- Uploading of all pieces of information from calculation headers into a well-arranged table.
- Simple filtration and searching according to the entered parameters.
- Fast opening of the selected file / calculation.

## MITCalc contact for the technical support of calculations:

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