Mechanical Engineering Library For HP952X STOCK # 2535 V1.1

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4	README95	TXT	6674	11-26-91	12:02a

Mechanical Engineer's Equation Library (README95.TXT)

Version 1.1 November 24th, 1991

Page

README.TXT is formatted for the printer or PC screen. README95.TXT is formatted for the HP95LX MEMO application or any word process

INSTALLING THE SOFTWARE

This software requires the user to be familiar with the HP Connectivity pack, the HP95LX filer, HP CALC solver, Lotus 123, and MSDOS file structures.

If you have the HP Connectivity pack, follow these instructions. Connect the HP95LX with the RS232 cable to the host PC. Run the APP95 program on your PC, then start the FILER. On the HP95LX start the FILER application. Go into remote mode on the PC FILER. It helps to use the split screen option. On the PC FILER use "MENU Options Dirs YES" so that subdirectory copying is allowed. Copy the ME-EQTS directory from the 5.25" floppy drive to the HP95LX. If you have space on the C: drive in the HP95LX, it is recommended that you place the equation subdirectories under the \_DAT subdirectory since HP CALC insists on looking there first and the small 95LX keyboard makes moving around the file structure difficult. I recommend that you not copy the README files at the root level of the 5.25" floppy onto your 95LX because of their large space and limited utility. Similarly, I wouldn't copy EQN-PRNT.EXE over either. They are useful at startup and when documenting large numbers of equations, but not otherwise.

If you do not have the HP Connectivity pack you will have to read the manual for your solution and work out how to copy files. There are many other methods, some involving hardware (such as PC based RAM card drive), 3rd party connectivity tools, and datacomm programs. There are simply too many alternate methods to document well.

Your equations should now be available for use. To load them into HP CALC, use "MENU, File" and then type in the name of the equation file of interest.

Page 1

# WHAT'S DIFFERENT ABOUT VERSION 1.1

The DYNAMICS subdirectory was added. In addition to the old NATFREQ.EQN file, the directory contains two new files 1STORDER.EQN and 2NDORDER.EQN. These equation groups deal with 1st and 2nd order mechanical systems for step force and free response, respectively. These two cases seem to be important to mechanical engineers in general.

A bug (ahem) in the COILS.EQN file was fixed. The first divide in the impact stress equation should have been a multiplication. It pays off sometimes to do a dimensional analysis of an equation....

WHAT'S IN THE LIBRARY

The library includes both equation (.EQN) files and 123 (.WK1) files. The .WK1 files are "database" files with unit conversions, simple geometric equations, and material properties. The major equation sets are all in .EQN files.

Equations were selected for the library on the basis of both general usefulness to mechanical engineers, applicability to HPCALC's solver (ie, algebraic equations). Because of these guidelines, subjects wherein engineers commonly start with a differential equation, such as dynamics and vibrations, cannot be handled in a general way. The common algebraic forms in dynamics are trivial (F=ma, v=wr, etc) and 1st & 2nd order differential equations, while commonly used, cannot be solved in the general case using the solver. Equations which require a high degree of physical visualization are also avoided, because of the nonexistant documentational graphics in HPCALC.

The disk contain the following equation sets;

### BEAMS

LAMS
Cantilever
CANT-EL.EQN (end load)
CANT-IL.EQN (intermediate load)
CANT-UL.EQN (uniform load)
CANT-ML.EQN (moment load)
Simply Supported
SS-CL.EQN (center load)
SS-IL.EQN (intermediate load)
SS-UL.EQN (uniform load)
SS-ML.EQN (moment load)
Fixed Ends
FIXED-CL.EQN (center load)
FIXED-IL.EQN (intermediate load)
FIXED-UL.EQN (uniform load)
• •

#### SPRINGS

COILS.EQN (Coil spring design) BELVILLE.EQN (Belleville washers) CANTBEAM.EQN (Cantilever beams) TORSION.EQN (Wire torsion springs)

#### GEARS

SPURS.EQN (Spur gear design) WORMS.EQN (Worm design)

### STRESS

MOHRS.EQN (Mohr Circle equations) TORSION.EQN (Torsional stress) PRESVESL.EQN (Pressure vessels) PRESSFIT.EQN (Press fit equations)

# THERMO

HEATXFER.EQN (Heat conduction) ENTROPY.EQN (What is entropy?) HUMIDITY.EQN (Steam table eqt) BERNOULI.EQN (Bernoulli's eqt) PIPEFLOW.EQN (Incompressible) IDEALGAS.EQN (Compressible) DRAG.EQN (Fluid drag, Cd)

# DYNAMICS

NATFREQ.EQN (Damped and undamped) 1STORDER.EQN (spring/damper) 2NDORDER.EQN (mass/spring/damper)

# PROPS

AREAPROP.WK1 (123, Inertia eqts) MASSPROP.WK1 (123, Mass Inertia) MECHPROP.WK1 (123, E, G, poisson) GASPROPS.WK1 (123, R, Cp, Cv, Mw) THERMAL.WK1 (123, heat transfer)

# MSC

MECONV.WK1 (123, conversion factors) ELECMOTR.EQN (Electric motor eqts) AUTO-HP.EQN (Automobile road hp)

Each directory contains a README.TXT file with further information about the local equations and/or 123 files. Each equation set contains comments and variable descriptions.

In addition to the mechanical engineering information and equations, the disk contains a simple utility to print out equation sets from their files. The program, called EQN-PRNT.EXE, prompts for the .EQN file to print out and then sends the contents of the file, formatted for ease of reading, to the printer. The program assumes the printer is capable of printing 80 characters only. This program is included because HP CALC doesn't offer a similar service and the author found the capability useful when documenting equation sets.

# SYSTEM REQUIREMENTS

Any mechanical engineer with an HP95LX or the APP95.EXE program and an MSDOS computer can use these equations. The equations take up ~15kbytes of disk space (a bargain!), the reference tables ~32kbytes.

# WHAT THIS EQUATION LIBRARY IS

The sole service provided in this equation library consists of pulling together generally recognized mechanical engineering equations and material property values from many sources. The author is not responsible for the usefulness or application of these equations. The user is particularly warned to be careful about material properties; always consult the manufacturer for detailed material information and/or test!

Compiled by Paul Harmon 10700 NE 31st Ave Vancouver, WA 98686

Compiled from; Conner Springs Corporation Design Handbook, Shigley "Mechanical Engineering Design (3rd Edition", Krieth & Black "Basic Heat Transfer", LNP Corporation plastic material properties brochures, Johnson Motor Corporation Design Handbook, and Fox & MacDonald "Introduction to Fluid Mechanics, 2nd Edition".

### MECHANICAL ENGINEER'S EQUATION LIBRARY

Version 1.1 November 24th, 1991

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```

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BEAMS	0	<dir></dir>	11	12-10-91	9:19p
SPRINGS	0	<dir></dir>	4	12-10-91	9:20p
GEARS	•	<dir></dir>	a	12-10-91	9:20p
MSC	1	<dir></dir>	2	12-10-91	9:20p
STRESS	0	<dir></dir>	4	12-10-91	9:20p
DYNAMICS	0	<dir></dir>	3	12-10-91	9:20p
PROPS	5	<dir></dir>	0	12-10-91	9:21p
THERMO	0	<dir></dir>	7	12-10-91	9:21p
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Volume in drive A has no label Directory of A:\ME-EQTS\BEAMS

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CANT-EL	EON	227	9-07	-91 1	11:37p
CANT-TI.	EON	377	9-07	' <b>-91</b> .	11:37p
CANT-III.	FON	249	9-07	-91	11:36p
CANT-MI.	EON	228	9-07	/-91	11:36p
CANT MIL	FON	233	9-07	-91	11:37p
	FON	510	9-07	-91	11:38p
22-III	FON	251	9-07	-91	11:39p
SS-UL	EQN	540	9-07	-91	11:40p
22-WT	EQN	342	9-07	/-91	11:410
FIXED-CI	LEQN	592	9-07	/_91	11:420
FIXED-1	LEQN	202		7_01	11 • 43n
FIXED-U	LEQN	287	9-07		11.425
README	TXT	701	9-24	1-91	8:49p
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Volume in drive A has no label Directory of A:\ME-EQTS\<u>MSC</u>

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MECONV	WK1	5532	9-05-91	12:24a
ELECMOTR	EQN	445	9-02-91	12:19a
AUTO-HP	EQN	485	9-05-91	12:00a
README	TXT	803	11-26-91	12:07a
	6 File(s)	17	75104 bvt	es free

Volume in drive A has no label Directory of A:\ME-EQTS\STRESS

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MOHRS	EQN	488	8-31-91	9:34p
TORSION	EQN	390	8-31-91	9:52p
PRESVESL	EQN	507	8-31-91	10:03p
PRESSFIT	EQN	555	8-31-91	10:28p
README	TXT	335	9-08-91	10:00p
	7 File(s)	1	75104 byte	s free

Volume in drive A has no label Directory of A:\ME-EQTS\DYNAMICS

•	<dir></dir>	•	12-10-91	9:20p
••	<dir></dir>	•	12-10-91	9:20p
NATFREQ	EQN	203	8-31-91	9:04p
<b>1STORDER</b>	EQN	267	11-23-91	10:05p
2NDORDER	EQN	614	11-23-91	11:12p
README	TXT	519	11-26-91	12:15a
(	6 File(s)	17	5104 bytes	s free

Page 7.

					Volume in drive A has no label Directory of A:\ME-EQTS\PROPS_			
					•	<dir></dir>	12-10-91	9:21p
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					AREAPROP WE	(1 2496	5 9-07-91	11:26p
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•		~ >>	12-10-91	9:200	README T	(T 119)	9-24-91	8:53p
COTIS	FON	519	11-26-91	1:40a	8 I	file(s)	175104 byte	s free
BELVILL	FEON	738	9-07-91	10:450				
CANTREAM	A FON	253	9-07-91	10:50p	Volume in	drive A ha	as no label	
TOPSTON	FON	406	9-07-91	11:06p	Directory	of A:\ME-	EQTS\THERMO	)
DEADME	TYT	440	9-24-91	8:540				-
<b>NDRD</b>	7 File(s	1	75104 byte	s free	•	<dir></dir>	12-10-91	9:21p
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_	<di< td=""><td>3&gt;</td><td>12-10-91</td><td>9:20p</td><td>HUMIDITY EQ</td><td>N 357</td><td>11-26-91</td><td>1:39a</td></di<>	3>	12-10-91	9:20p	HUMIDITY EQ	N 357	11-26-91	1:39a
•	<di< td=""><td>R&gt;</td><td>12-10-91</td><td>9:20p</td><td>BERNOULI EQ</td><td>235 N</td><td>9-02-91</td><td>9:30a</td></di<>	R>	12-10-91	9:20p	BERNOULI EQ	235 N	9-02-91	9:30a
SPURS	EON	308	8-31-91	7:51p	PIPEFLOW EQ	<u>N</u> 326	9-02-91	9:50a
WORMS	EON	399	8-31-91	8:32p	DRAG EQ	N 96	9-02-91	9:57a
README	TXT	173	9-08-91	11:53a	IDEALGAS EQ	N 735	9-02-91	10:31a
	5 File(s	) 1	.75104 byte	s free	10 F	'ile(s)	175104 byte	s free

### ME-EQTS\BEAMS

README.TXT

Beam Equation Information

Filename Abbreviations: CANT=Cantilevered SS=Simply Supported FIXED=Fixed Ends

Coordinate system; for all equations, the left end of the beam is 0,0. For cantilevered beams, the left end is fixed. Left is negative, right is positive, down is negative, up is positive.

The user is reminded of the principle of superposition. By using the CNTRL COPY and CNTRL PASTE functions several different load cases can be combined into one for a particular problem.

### ME-EQTS\SPRINGS README.TXT

The equations for coil springs include all the usual ones (K, Stress, etc) for round wire plus natural frequency and impact stress formulae.

Page 8

The equations for the Bellville springs were culled from a designer's guide published by the Connor Spring company. The author has no experience with these equations and, as with all equations in the ME pack, cannot guarantee their accuracy. There is no substitute for empirical verification.

ME-EQTS\GEARS README.TXT

SPURS.EQN has the relations for pitch, addendum, etc necessary for designing spur gears.

WORMS.EQN contains equations for lead angle, efficiency, and locking torque.

# ME-EQTS\MSC README.TXT

MECONV.WK1 is a 123 file which contains various common mechanical engineering conversion factors not contained in the HP CALC conversion table.

Open the file in 123. In HPCALC use "RCL @" keystrokes to "grab" the conversion factor you want. The HP95LX will automatically switch to 123, ask which cell you want, and put the contents of that cell in the x-register of the calculator.

ELECMOTR.EQN is a set for electric motor design.

AUTO-HP.EQN is a group of rather emprical equations for the estimation of horsepower required for an automobile on the road. The origin of these equations is rather obscure (based on the author's notes from a Stanford IC engine course) but they are included for the fun of it, and because the author feels ME's in general are interested in things automotive.

ME-EQTS\STRESS README.TXT

It is felt by the author that the titles of each file in the stress subdirectory make the contents self evident. Each file is aimed at a particular problem in stress analysis;

PRESVESL.EQN => Pressure vessel probs TORSION.EQN => Torsional stress progs MOHRS.EQN => Solution, Mohr's Circle PRESSFIT.EQN => Press fit problems.

### ME-EQTS\DYNAMICS README.TXT

NATFREQ.EQN contains the equations for calculating the natural frequency (damped and undamped) of a second order system.

Page ?

1STORDER.EQN has both time and frequency models of a spring/damper system excited by a step function force. This file and 2NDORDER.EQN are particularly well suited for use with the GRAPH function of HPCALC.

2NDORDER.EQN has both time and frequency models of a mass/spring/damper system excited by an initial displacement and/or velocity. This model reports the natural response of a system.

### ME-EQTS\PROPS README.TXT

The .WK1 123 files in PROPS are a database of numbers and simple formulae to be used in conjunction with several other formula groups. The idea is to copy cells out of the 123 files and paste them into an open equations set on HP CALC.

To do this, open the file in 123 and use the CTRL COPY function. Use the CTRL PASTE function in HP CALC to put the information either into the x-register (numeric) or equation stack (right hand side of HP CALC, equations Read the 123 prompts, and remember that only the text contained in the highlighted region will be copied. Contents outside the highlight will not be copied.

AREAPROP.WK1 contains equations for moments of inertia, area and centroid.

MASSPROP.WK1 contains mass moment of inertia, volume, and surface area equations for various shapes.

MECHPROP.WK1 has Young's modulus, Shear modulus, density, and poisson's ratio for various ME materials, English and Metric units.

GASPROPS.WK1 has R, Cp, Cv, k, Mw and density for various gases, metric units.

THERMAL.WK1 is for thermo/fluid properties, consists of viscosity u, thermal conductivity k, specific heat Cp, and density of various materials, liquid, gas and solid.

ME-EQTS\THERMO README.TXT

HEATXFER.EQN => Conduction, convection, Radiation, and heat capacity.

ENTROPY.EQN => Internal energy, enthalpy, entropy equations.

HUMIDTY.EQN => Relative humidity, specific humidity, 0 degrees Centigrade to 100 degrees Centigrade model of the steam table (metric only).

BERNOULI.EQN => Bernoulli and pitot tube equations.

PIPEFLOW.EQN => Equations for fully developed, incompressible flow in a pipe. Head loss, average velocity, laminar friction factor. For turbulent friction factor, consult a good handbook or the piping manufacturer.

DRAG.EQN => Fluid drag, Cd eqt.

IDEALGAS.EQN => Boyle's law, PV=mRT, Bernoulli, velocity of sound, Mach number, compressible flow equations.

Page 10. Last page.