COMPETITOR RESOURCE

Haas Automation is a sponsor of the 2023 SkillsUSA CNC Machining Competitions. We are committed to providing materials for Regional and State competitions throughout the United States for the 2023 CNC Machining Competitions.

In addition, we are providing a list of resources to help prepare students to enter the CNC Machining competitions and the workforce of our industry, feeling well-equipped for success. Please see the following pages for resources or visit our website at haascnc.com.

About the Competition:

Regional and State-level CNC Milling Programmer, CNC 2-Axis Turning, CNN 3-Axis Milling, and CNC 5-Axis Milling Programmer competitions will test two major skills areas (1) a CNC theory test and (2) CAM programming, with optional scoring for Process Control, and Oral Professional Development Assessment

CNC Theory Test:

The CNC theory test is a set of multiple-choice questions closely related to the CNC subject area of focus for the competition, i.e., milling or turning.

Programming:

The programming portion of the competition will provide competitors with access to a part drawing, STEP model, and Process Plan. It is the competitor's job to use the provided documents to complete a CAM program. If run, the program would produce a machined part that is in accordance with the Process Plan, collision-free, and accurate to the part drawing provided. The drawing will be complete with multiple views making it easy for competitors to visualize the part and understand its geometry. The Process Plan will provide setup instructions, a sequence of operations, and tool data. Contestant numbers must be used as the name for the CAM file. If this step is missed, the competitor will receive 0 points. Remember, save early, save often.

Competitors will be provided with project documents mentioned above on the day of their competition, but **competitors must provide the following items to compete successfully.**

- (Required) Laptop or PC with access to CAM software (Mastercam or Fusion360)
- (Required) Pen or pencil for notes or written calculations
- (Optional) Basic calculator

Recommended Competitor Preparation

Set yourself up for success by committing to continuous learning. Haas Automation, and other supporting partners, offer an array of opportunities for everyone to learn about the principles of CNC machining. Get ahead by preparing yourself as a competitor before and after competitions.

Haas Certification Program

These online courses are designed to provide the basic knowledge necessary to get started as a CNC machine operator or CNC machinist. They introduce basic CNC machine operation, proper machine safety, and fundamental machining processes. For more information and to sign-up for the free online courses, visit: https://www.learn.haascnc.com

Haas Programming Workbooks

These programming workbooks provide the basic principles to program Haas Mills and Haas Lathes. Numerous exercises throughout the workbook enable users to build their skills at their own pace. Answer Books are also available. To download, visit the Haas Learning Resources webpage: https://www.haascnc.com/myhaas/Haas_Learning_Resources.htm

Haas Video Library

The Haas Video Library gives you access to thousands of videos recorded specifically to help Haas CNC users everywhere to grow their skills and understanding of CNC machining to maximize their abilities. Access videos directly from the Haas Video Library via the Haas YouTube channel or using the Quick Picklist of the Haas Learning Resources page, which organizes a handful of entry- to advanced-level videos to help get you started. For the complete Video Library, visit: https://www.haascnc.com/video.html Or, for the shortened Quick Picklist, visit: https://www.haascnc.com/myhaas/Haas_Learning_Resources.html

CAM Programming Training and Software

Partners Mastercam and Autodesk Fusion360 provide access to software and video training programs. Please visit the links below for information on accessing software and training resources.

Mastercam Learning Content: https://university.mastercam.com/
Mastercam Software Access for SkillsUSA: https://www.mastercam.com/skillsusa/
Contact Email: education@mastercam.com

Autodesk Fusion360 Training Courses:
https://help.autodesk.com/view/fusion360/ENU/courses/#manufacturing-milling-turning-and-inspection
Autodesk Fusion360 Software Access:
https://damassets.autodesk.net/content/dam/autodesk/www/fusion-360/Fusion%20Single%20Install%20Instructions.pdf

Autodesk Fusion360 Webinars:

One-Hour Webinar

Educators will get a high-level walkthrough of Autodesk, specifically focusing on our integrated, cloud-based Fusion 360 CAD/CAM software. Topics include: how to download Fusion 360 for free, how to assign students licenses, and how to build a class.

Two-Hour Hands-On Webinar

Educators will learn the basics of Fusion 360 by walking through an introductory, real-world, classroom-ready project. Topics include 2D sketching, 3D extrusions, creating assemblies, and exporting 3D models for manufacturing.

Visit https://www.autodesk.com/campaigns/education/webinar-series to register for one of our free Fusion 360 webinars.

Autodesk Fusion360 Contact Email: amy.shapiro@autodesk.com

Competitor Instruction:

Theory Test:

Add your contestant number in the space provided. If printed, add the contestant number on each page. For each multiple-choice question, select the best answer that applies. Be sure to read each question carefully before choosing the answer. Write neatly. Make sure your contestant number is on the test before submitting. Questions without an answer receive zero points.

Programming:

Open the STEP model in your CAM software of choice. Save the file using your contestant number in the file name. Use the provided documents (Drawing and Process Plan) to program the model using the information provided (Ex. Stock Setup, Operation Sequence, Tool Data, Feed and Speeds, and WCS). **Save OFTEN.** When done, check the entire program from start to finish, and save. The judged file should resemble a perfect program, which, if run on a machine, would produce a machined part that is accurate to the print and collision-free. Submit your completed program via USB flash drive.

DECIMAL EQUIVALENT CHART .0059 – .0980

Decimal Equiv.	Drill Size	mm	Tap Sizes	Decimal Equiv.	Drill Size	mm	Tap Sizes
.0059	97	0.150		.0320	67	0.813	
.0063	96	0.160		.0330	66	0.838	
.0067	95	0.170		.0350	65	0.889	
.0071	94	0.180		.0360	64	0.914	
.0075	93	0.191		.0370	63	0.940	
.0079	92	0.201		.0380	62	0.965	
.0083	91	0.211		.0390	61	0.991	
.0087	90	0.221		.0400	60	1.016	
.0091	89	0.231		.0410	59	1.041	
.0095	88	0.241		.0420	58	1.067	
.0100	87	0.254		.0430	57	1.092	
.0105	86	0.267		.0465	56	1.181	
.0110	85	0.279		.0469	3/64	1.191	#0-80
.0115	84	0.292		.0520	55	1.321	
.0120	83	0.305		.0550	54	1.397	
.0125	82	0.318		.0595	53	1.511	#1-64 · #1-72
.0130	81	0.330		.0625	1/16	1.588	
.0135	80	0.343		.0635	52	1.613	
.0145	79	0.368		.0670	51	1.702	
.0156	1/64	0.397		.0700	50	1.778	#2-56 · #2-64
.0160	78	0.406		.0730	49	1.854	
.0180	77	0.457		.0760	48	1.930	
.0200	76	0.508		.0781	5/64	1.984	
.0210	75	0.533		.0785	47	1.994	#3-48
.0225	74	0.572		.0810	46	2.057	
.0240	73	0.610		.0820	45	2.083	#3-56
.0250	72	0.635		.0860	44	2.184	
.0260	71	0.660		.0890	43	2.261	#4-40
.0280	70	0.711		.0935	42	2.375	#4-48
.0292	69	0.742		.0938	3/32	2.381	
.0310	68	0.787		.0960	41	2.438	
.0313	1/32	0.794		.0980	40	2.489	

Tap drill sizes above based on approximately 75% full thread
Tap # Sizes #0 = .060 #1 = .073 #2 = .086 #3 = .099 #4 = .112
Tap # x .013 + .060 = Thread # OD

DECIMAL EQUIVALENT CHART .0995 – .2969

Decimal Equiv.	Drill Size	mm	Tap Sizes	Decimal Equiv.	Drill Size	mm	Tap Sizes
.0995	39	2.527		.1875	3/16	4.763	#12-32
.1015	38	2.578	#5-40	.1890	12	4.801	
.1040	37	2.642	#5-44	.1910	11	4.851	
.1065	36	2.705	#6-32	.1935	10	4.915	
.1094	7/64	2.778		.1960	9	4.978	
.1100	35	2.794		.1990	8	5.055	
.1110	34	2.819		.2010	7	5.105	1/4-20
.1130	33	2.870	#6-40	.2031	13/64	5.159	
.1160	32	2.946		.2040	6	5.182	
.1200	31	3.048		.2055	5	5.220	
.1250	1/8	3.175		.2090	4	5.309	
.1285	30	3.264		.2130	3	5.410	1/4-28
.1360	29	3.454	#8-32 · #8-36	.2188	7/32	5.556	1/4-32
.1405	28	3.569		.2210	2	5.613	
.1406	9/64	3.572		.2280	1	5.791	
.1440	27	3.658		.2340	A	5.944	
.1470	26	3.734		.2344	15/64	5.953	
.1495	25	3.797	#10-24	.2380	B	6.045	
.1520	24	3.861		.2420	C	6.147	
.1540	23	3.912		.2460	D	6.248	
.1563	5/32	3.969		.2500	1/4&E	6.350	
.1570	22	3.988		.2570	F	6.528	5/16-18
.1590	21	4.039	#10-32	.2610	G	6.629	
.1610	20	4.089		.2656	17/64	6.747	
.1660	19	4.216		.2660	H	6.756	
.1695	18	4.305		.2720	I	6.909	5/16-24
.1719	11/64	4.366		.2770	J	7.036	
.1730	17	4.394		.2810	K	7.137	
.1770	16	4.496	#12-24	.2813	9/32	7.144	5/16-32
.1800	15	4.572		.2900	L	7.366	
.1820	14	4.623	#12-28	.2950	M	7.493	
.1850	13	4.699		.2969	19/64	7.541	

Tap drill sizes above based on approximately 75% full thread
Tap # Sizes #5 = .125 #6 = .138 #8 = .164 #10 = .190 #12 = .216
Tap # x .013 + .060 = Thread # OD

Decimal Equivalent Chart .3020 – 1.000

Decimal Equiv.	Drill Size	mm	Tap Sizes	Decimal Equiv.	Drill Size	mm	Tap Sizes
.3020	N	7.671		.5625	9/16	14.288	5/8-18
.3125	5/16	7.938	3/8-16	.5781	37/64	14.684	5/8-24
.3160	O	8.026		.5938	19/32	15.081	
.3230	P	8.204		.6094	39/64	15.478	11/16-12
.3281	21/64	8.334		.6250	5/8	15.875	
.3320	Q	8.433	3/8-24	.6406	41/64	16.272	11/16-20 · 11/16-24
.3390	R	8.611		.6563	21/32	16.669	3/4-10
.3438	11/32	8.731	3/8-32	.6719	43/64	17.066	
.3480	S	8.839		.6875	11/16	17.462	3/4-16
.3580	T	9.093		.7031	45/64	17.859	3/4-20
.3594	23/64	9.128		.7188	23/32	18.256	
.3680	U	9.347	7/16-14	.7344	47/64	18.653	13/16-12
.3750	3/8	9.525		.7500	3/4	19.050	13/16-16
.3770	V	9.576		.7656	49/64	19.447	13/16-20 · 7/8-9
.3860	W	9.804		.7813	25/32	19.844	
.3906	25/64	9.922	7/16-20	.7969	51/64	20.241	7/8-14
.3970	X	10.084		.8125	13/16	20.637	
.4040	Y	10.262	7/16-28	.8281	53/64	21.034	7/8-20
.4063	13/32	10.319		.8438	27/32	21.431	
.4130	Z	10.490		.8594	55/64	21.828	15/16-12
.4219	27/64	10.716	1/2-13	.8750	7/8	22.225	15/16-16 · 1.0-8
.4375	7/16	11.113		.8906	57/64	22.622	15/16-20
.4531	29/64	11.509	1/2-20	.9063	29/32	23.019	
.4688	15/32	11.906	1/2-28	.9219	59/64	23.416	1.0-12
.4844	31/64	12.303	9/16-12	.9375	15/16	23.813	
.5000	1/2	12.700	9/16-18	.9531	61/64	24.209	1.0-20
.5156	33/64	13.097	9/16-24	.9688	31/32	24.606	
.5313	17/32	13.494	5/8-11	.9844	63/64	25.003	
.5469	35/64	13.891		1.000	1	25.400	

Tap drill sizes above based on approximately 75% full thread
A decimal equivalent chart can be displayed on a Haas control by pressing the HELP/CALC button, and then selecting the Drill Table tab. Use the jog handle or cursor keys to scroll through the chart.

Mill and Lathe Formulas

Cutting Speed (surface feet/min.)
SFM = 0.262 x DIA x RPM

Revolutions Per Minute
RPM = 3.82 x SFM ÷ DIA

Feed Rate (in/min.)
IPM = FPT x T x RPM

Feed Per Revolution
FPR = IPM ÷ RPM

Feed Per Tooth (in)
FPT = IPM ÷ (RPM x T)

Metal Removal Rate
MRR = W x d x F

Converting IPR to IPM
IPM = IPR x RPM

Converting IPM to IPR
IPR = IPM ÷ RPM

Converting SFM to SMPM
SMPM = SFM x .3048

Converting IPR to MMPR
MMPR = IPR x 25.40

Distance over Time (in minutes)
L = IPM x TCm

Time Cutting over Distance (Mill) (minutes)
TCm = L ÷ IPM

Time Cutting over Distance (Mill) (seconds)
TCs = L ÷ IPM x 60

INCH METRIC CONVERSION

mm x 0.03937 = in.	in. x 25.4 = mm
m x 39.37 = in.	in. x 0.0254 = m
m x 3.2808 = ft	ft x 0.3048 = m
m x 1.0936 = yd	yd x 0.9144 = m
km x 0.621 = mi	mi x 1.6093 = km
Celsius to Fahrenheit (°C x 1.8) + 32 = °F	Fahrenheit to Celsius (°F - 32) ÷ 1.8 = °C

Drill Point Depth & Countersink Diameter Formulas

To calculate drill tip depth for a chamfer diameter,
or drill point depth for a required drilling depth:

Drill Point Angle (DPA)	Factor
60°	0.866 x Dia. = Point Depth
82°	0.575 x Dia. = Point Depth
90°	0.500 x Dia. = Point Depth
118°	0.300 x Dia. = Point Depth
120°	0.288 x Dia. = Point Depth
135°	0.207 x Dia. = Point Depth

Example: To calculate for a 118-degree drill tip depth, multiply the dia. by 0.3

i.e., 0.250 drill diameter x .3 = 0.075 drill tip depth