Fundamentals of Machining

Objective

To gain a proficiency in basic hand tools and small machinery. To have a good understanding of cutting speed, feed rate, and threading.

Background

The Drill Press allows the operator to drill straight holes into a workpiece using a variety of different tools. The tools used in drilling operations are held in a three-jaw drill chuck and are rotated at high speed. With the workpiece clamped securely the hole drilled will be straight and not wander, if correct procedures are followed. This allows for a greater accuracy to be obtained than using a handheld power drill. The drill press can also apply a much greater force on the drill bit resulting in more consistent chip formation, and the ability to drill through hard materials such as steel with a greater ease.

Drill presses can come in both bench-top models and free-standing pedestal models. The model in the student shop is a pedestal model drill press shown in Figure 1. This allows a greater range of work heights to be accommodated. The drill press has a range of 12 speeds from 250 to 3000 RPM. Speed is set by changing belt positions on cluster pulleys. The cluster pulleys and the speed configuration diagram are shown in Figure 2.

The Drill Press can also perform other operations besides drilling but will not be covered in basic training. These processes include but are not limited to; reaming, countersinking, counterboring, and power tapping (with a reversing tapping head).

Apparatus and Equipment Overview

The following components will be used in this lab:

- 1 x combination square
- 1 x centre punch
- 1 x drill press
- 1 x 3.3mm (0.1299in) drill bit
- 1 x M4 tap
- 1 x tap handle
- 1 x deburring tool
- 1 x pre-prepared acrylic base

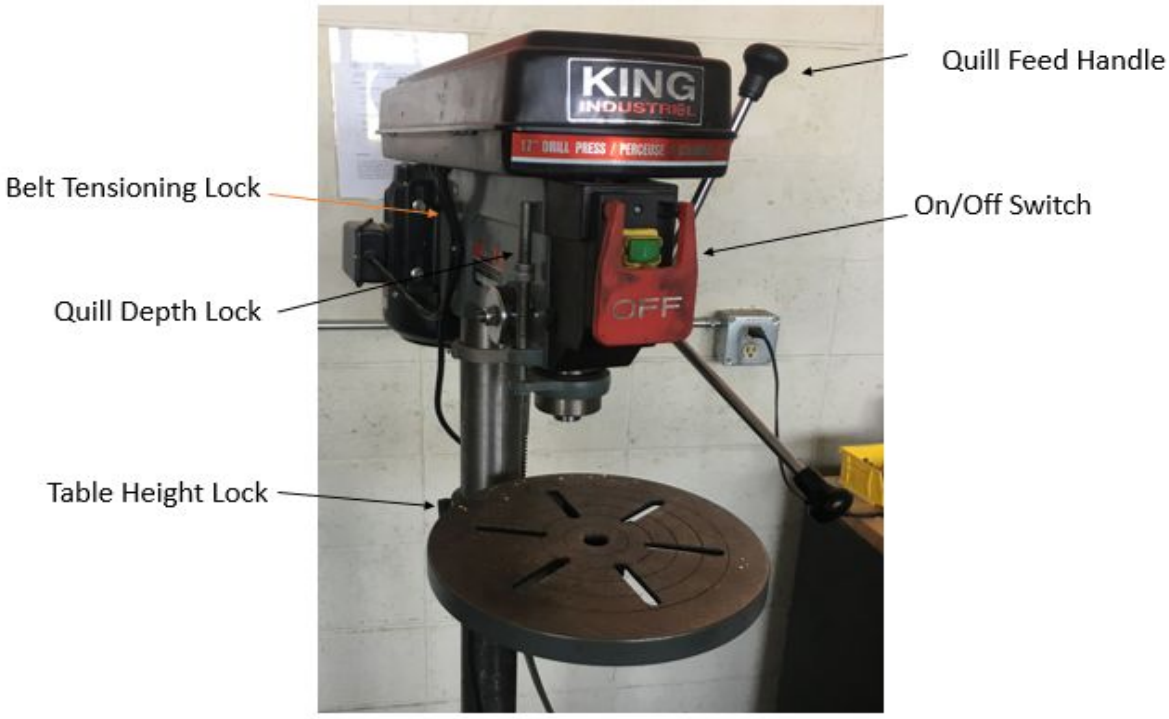


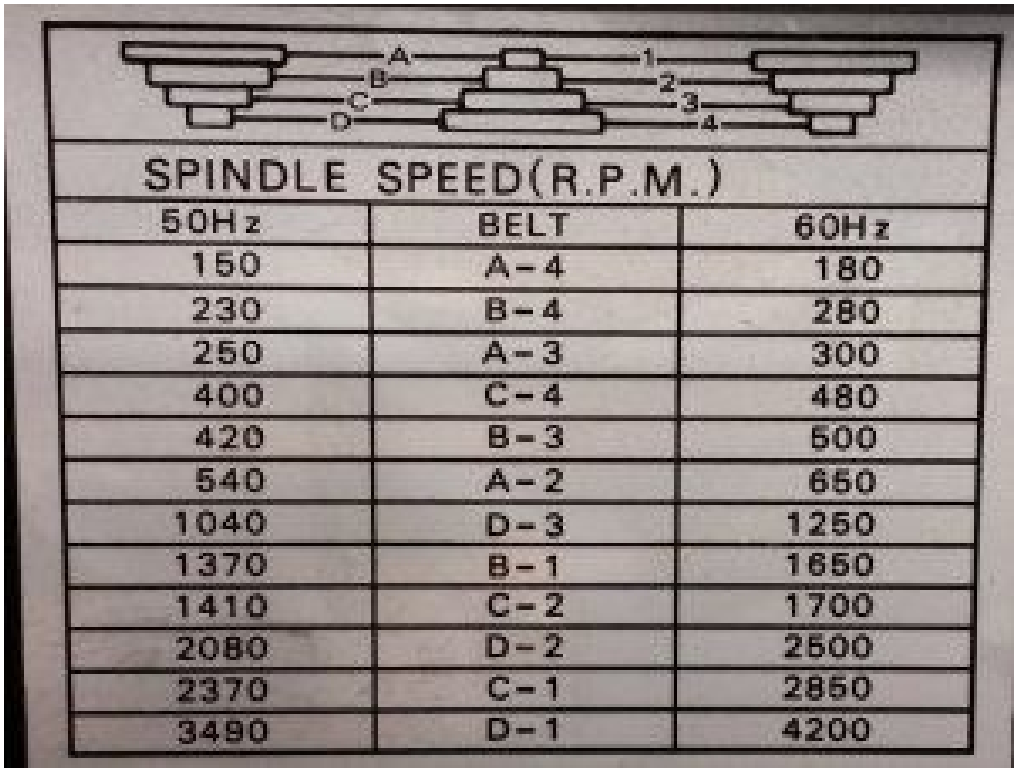
Figure 1. Pedestal Model Drill Press

Figure 2. Pedestal Model Drill Press Belt Casing

Figure 3. Deburring Tool

Figure 4. Tap (left) and Handles (middle, right)

Figure 5. Centre Punch



SPINDLE SPEED(R.P.M.)

50Hz	BELT	60Hz
150	A-4	180
230	B-4	280
250	A-3	300
400	C-4	480
420	B-3	500
540	A-2	650
1040	D-3	1250
1370	B-1	1650
1410	C-2	1700
2080	D-2	2500
2370	C-1	2850
3490	D-1	4200

Figure 6. Pulley Speed Chart

INCH / METRIC TAP DRILL SIZES & DECIMAL EQUIVALENTS

DRILL SIZE	DECIMAL EQUIVALENT	TAP SIZE
80	.0135	
79	.0145	
1/64	.0156	
78	.0160	
77	.0180	
76	.0200	
75	.0210	
74	.0225	
73	.0240	
72	.0250	
71	.0260	
70	.0280	
69	.0292	
68	.0310	
1/32	.0312	
67	.0320	
66	.0330	
65	.0350	
64	.0360	
63	.0370	
62	.0380	
61	.0390	
60	.0400	
59	.0410	
58	.0420	
57	.0430	
56	.0465	
3/64	.0469	0 - 80
55	.0520	
54	.0550	
53	.0595	1 - 64, 72
1/16	.0625	
52	.0635	
51	.0670	
50	.0700	2 - 56, 64
49	.0730	
48	.0760	
5/64	.0781	
47	.0785	3 - 48
46	.0810	
45	.0820	3 - 56
44	.0860	
43	.0890	4 - 40
42	.0935	4 - 48
3/32	.0938	
41	.0960	
40	.0980	
39	.0995	
38	.1015	5 - 40
37	.1040	5 - 44
36	.1065	6 - 32
7/64	.1094	
35	.1100	
34	.1110	
33	.1130	6 - 40
32	.1160	
31	.1200	
1/8	.1250	
30	.1285	
29	.1360	8 - 32, 36
28	.1405	
9/64	.1406	
27	.1440	
26	.1470	
25	.1495	10 - 24
24	.1520	
23	.1540	
5/32	.1562	
22	.1570	
21	.1590	10 - 32
20	.1610	
19	.1660	
18	.1695	
11/64	.1719	
17	.1730	
16	.1770	12 - 24
15	.1800	
14	.1820	12 - 28
13	.1850	
3/16	.1875	
12	.1890	
11	.1910	

DRILL SIZE	DECIMAL EQUIVALENT	TAP SIZE
10	.1935	
9	.1960	
8	.1990	
7	.2010	1/4 - 20
13/64	.2031	
6	.2040	
5	.2055	
4	.2090	
3	.2130	1/4 - 28
7/32	.2188	
2	.2210	
1	.2280	
A	.2340	
15/64	.2344	
B	.2380	
C	.2420	
D	.2460	
1/4	.2500	
E	.2570	5/16 - 18
F	.2610	
G	.2656	
17/64	.2660	
H	.2720	
I	.2770	5/16 - 24
J	.2810	
K	.2812	
9/32	.2900	
L	.2950	
M	.2969	
19/64	.3020	
N	.3125	3/8 - 16
5/16	.3160	
O	.3230	
P	.3281	
21/64	.3320	
Q	.3390	3/8 - 24
R	.3438	
11/32	.3480	
S	.3580	
T	.3594	
23/64	.3680	7/16 - 14
U	.3750	
3/8	.3770	
V	.3860	
W	.3906	
25/64	.3970	7/16 - 20
X	.4040	
Y	.4062	
13/32	.4130	
Z	.4219	
27/64	.4375	1/2 - 13
7/16	.4531	
29/64	.4688	1/2 - 20
15/32	.4844	
31/64	.5000	9/16 - 12
1/2	.5156	
33/64	.5312	9/16 - 18
17/32	.5469	5/8 - 11
35/64	.5625	
9/16	.5781	
37/64	.5938	5/8 - 18
19/32	.6094	
39/64	.6250	
5/8	.6406	
41/64	.6562	
21/32	.6719	3/4 - 10
43/64	.6875	
11/16	.7031	3/4 - 16
45/64	.7188	
23/32	.7344	
47/64	.7500	
3/4	.7656	
49/64	.7812	7/8 - 9
25/32	.7969	
51/64	.8125	
13/16	.8281	7/8 - 14
53/64	.8438	
27/32	.8594	
55/64	.8750	
7/8	.8906	1 - 8
57/64	.9062	
29/32		

DRILL SIZE	DECIMAL EQUIVALENT	TAP SIZE
59/64	.9219	1 - 12
15/16	.9375	1 - 14
61/64	.9531	
31/32	.9688	
63/64	.9844	1 1/8 - 7
1	1.0000	
1 3/64	1.0469	1 1/8 - 12
1 7/64	1.1094	1 1/4 - 7
1 1/8	1.1250	
1 11/64	1.1719	1 1/4 - 12
1 7/32	1.2188	1 3/8 - 6
1 1/4	1.2500	
1 19/64	1.2969	1 3/8 - 12
1 11/32	1.3438	1 1/2 - 6
1 3/8	1.3750	
1 27/64	1.4219	1 1/2 - 12
1 1/2	1.5000	

METRIC TAP	TAP DRILL (mm)	DECIMAL (Inch)
M1.6 x 0.35	1.25	.0492
M1.8 x 0.35	1.45	.0571
M2 x 0.4	1.60	.0630
M2.2 x 0.45	1.75	.0689
M2.5 x 0.45	2.05	.0807
M3 x 0.5	2.50	.0984
M3.5 x 0.6	2.90	.1142
M4 x 0.7	3.30	.1299
M4.5 x 0.75	3.70	.1457
M5 x 0.8	4.20	.1654
M6 x 1	5.00	.1968
M7 x 1	6.00	.2362
M8 x 1.25	6.70	.2638
M8 x 1	7.00	.2756
M10 x 1.5	8.50	.3346
M10 x 1.25	8.70	.3425
M12 x 1.75	10.20	.4016
M12 x 1.25	10.80	.4252
M14 x 2	12.00	.4724
M14 x 1.5	12.50	.4921
M16 x 2	14.00	.5512
M16 x 1.5	14.50	.5709
M18 x 2.5	15.50	.6102
M18 x 1.5	16.50	.6496
M20 x 2.5	17.50	.6890
M20 x 1.5	18.50	.7283
M22 x 2.5	19.50	.7677
M22 x 1.5	20.50	.8071
M24 x 3	21.00	.8268
M24 x 2	22.00	.8661
M27 x 3	24.00	.9449
M27 x 2	25.00	.9843
M30 x 3.5	26.50	1.0433
M30 x 2	28.00	1.1024
M33 x 3.5	29.50	1.1614
M33 x 2	31.00	1.2205
M36 x 4	32.00	1.2598
M36 x 3	33.00	1.2992
M39 x 4	35.00	1.3780
M39 x 3	36.00	1.4173

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Pre-Lab Preparation

Before arriving in the lab, students should review the lab manual and familiarize themselves with the lab setup and procedures. Students must also watch this drill press video (https://www.youtube.com/watch?v=nPxbl1b4gP8&list=PLA-oTz8kRbrpqA6k87QrNDGXWEmTr2is8&index=3) in preparation for the lab.

Prelab Questions

What is the first step when changing speed on a drill press?

When in the shop, what PPE should you always wear?

How much force should you use when tapping plastic?

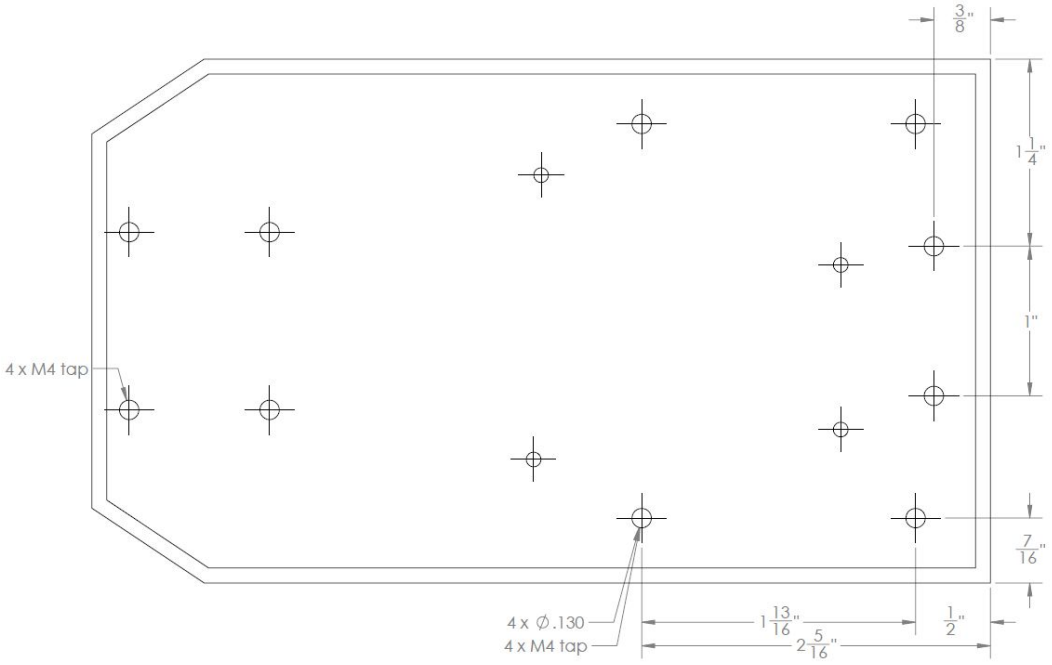
What is the RPM you should use for a 1/4in drill bit with aluminium?

What drill size should you use to predrill a hole for an M4 x 0.7 tap?

BONUS: What's the Brunsfield mascot?

Procedure

1. The first half of the lab will be spent discussing the class, and how teams will work.
2. Each team will grab a premade base plate.
3. With pencil, you will scribe the hole locations that need to be drilled. You will also find the schematics in the lab.



4. Centre punch each hole.
5. Drilling
    a. Make sure the drill press is using the correct speed for your material and your drill bit size. To change speeds:
        i. Power off and unplug the machine.
        ii. Open the belt casing.
        iii. Unlock then detention the motor.
        iv. Follow the pulley speed chart to choose the correct pulleys.
        v. Tension then lock the motors.
        vi. Close the casing.
    b. Insert your drill bit into the Jacob's Chuck.
    c. Drill through the plastic in a pecking motion.
6. Tapping
    a. Make sure your tap lines up with the hole.
    b. Use the handle to twist the taps in. This should not take much force.
    c. If the tap gets stuck, back out and go in again.

Typical Values for SFM when using High Speed Steel (HSS) drill bits are:

Steel	80 SFM
Stainless Steel	40 SFM
Brass	250 SFM
Aluminium	300 SFM
Plastics	100 – 200 SFM

Examples:

Drilling a ½" hole in Steel

CS (steel) = 80 SFPM
Drill Diameter = ½"

RPM = 4 x CS/DIA.
= 4 x 80/.5
= 640 RPM

Drilling a ¼" hole in Plastic

CS (Plastic) = 150SFPM
Drill Diameter = ¼"

RPM = 4 x CS/DIA.
= 4 x 150/.25
= 2400 RPM

General Rules and Safety

1. Following the completion of basic training, students will be permitted to use the Brunsfield Centre's workshop, and only those whom have already completed basic training will have access. Basic training will however grant limited access to the space as students will not have access to the mill, lathe, and welding area without having completed subsequent trainings for the respective equipment.
2. It is important to never work alone in the shop and to always have a supervisor on duty in the space. If working alone there is no one to help in the case of an accident or injury which makes it very dangerous.
3. Safety glasses must always be worn within the workshop. Safety glasses must be worn even if a face shield or welding helmet is being used overtop of them. Never approach anyone actively working the workshop without wearing safety glasses.
4. Proper footwear must be worn when working in the workshop to avoid hazardous situations (e.g. sparks, sharp metal, hot chips from operations) where the inappropriate footwear would cause greater levels of risk/harm. Closed-toed shoes must be worn. Not

flip flops, crocs, mesh-toed running shoes or and similar style or type of footwear. Steel-toed or similar footwear is recommended when working on larger, heavier projects.

5. Clothing that is long, baggy and/or loose must be rolled up. Strings on the front of a hoodie and hanging jewelry must be tucked under a shirt or taken off. Rings must not be worn inside of the machine shop. Long hair must also be tied back and up. These rules are in place to avoid the danger of having machinery grab and pull you into them causing severe harm.
6. No food or drink should be brought into the workshop. There are many chemicals, coolants and other contaminants that can be harmful if ingested.
7. The Brunsfield centre is a serious workspace and must be treated as one. Pranks, rough-housing, and general fooling around while within the workshop will not be tolerated. Any behavior deemed unprofessional and to this way by a supervisor will be met with an immediate suspension of shop privileges.
8. All persons within the MTC and Brunsfield Centre must always be of good health both physically and mentally as well as not being under the influence of any drugs and or alcohol.
9. A first aid kit is located within the Brunsfield office (Room A139). Any injury severe or small should be reported to a supervisor and an incident report should be filled. In the case a supervisor is not present, contact the nearest designated first aider (a list of first aiders can be found on the main door).
10. An emergency spill kit is available in the Brunsfield Centre. The spill kit can be used to clean and or contain hazardous materials that get spilled in the shop. A supervisor must be advised whenever the spill kit is used.
11. There are fire extinguishers and emergency stops located throughout the Brunsfield Centre. There is one fire extinguisher located at each of the main entrance doors, and one near the designated welding area. There are three emergency stops located at the main entrances and in the office. Students should be familiar with the location of each fire extinguisher. If an individual is not familiar with these locations, they should request the information from a supervisor their first time in the workshop.
12. Students are responsible for knowing their own limited knowledge of facilities and equipment, and to ask for assistance from a supervisor when encountering any unfamiliar equipment or processes (i.e. if you're not sure: Ask). Supervisors are there to help with any matter pertaining to the workshop and would much rather taking the time to explain something many times then having someone get injured or equipment break because of improper use of the space.
13. Before working with unfamiliar materials and chemicals, become familiar with the product's handling procedures. MSDS (Material Safety Data Sheets) info can be obtained by using the Google search engine and typing "MSDS" followed by the product name and/or asking a supervisor to see the MSDS.
14. Students as well as supervisors are entitled to a safe working environment. Safety is everyone's responsibility, thus anyone witnessing any unsafe behavior or working practices must advise a supervisor immediately.
15. Any damaged equipment must be reported to a supervisor immediately to ensure shop safety and that the issue related to the equipment is correctly addressed. A supervisor

must also be notified in the case of a broken tool to ensure that the tool was being used properly as to avoid damage of future tools.

16. Students are responsible for keeping the workshop clean and tidy. It is required that students clean up any work areas or machines that have been used after you have finished. The floor must be kept free of debris and tripping hazards. All tools must be put back in their proper places after use. Unplug all power tools while not in use.