Clock 29 FDM - Equipment

The following equipment is desirable: -

CNC Router or Laser or Waterjet and if not one of these then a Scrollsaw or a Bandsaw.
Small Lathe, this is not absolutely essential but it would make making the clock a lot easier for all of the round parts that are needed.

Small Milling machine or **Pedestal Drill** with work holding vice. There are a lot of holes to be drilled and cleaned up after CNC machining and fabrication so the drill is pretty much essential. It may be possible to get away with an ordinary electric drill in a stand but a work holding vice is still necessary.

Drill Bits in the following sizes, Ø2mm, Ø1.9mm, Ø2.1mm, OR if you are working in inches No 49, No 47, N0 45

Hand tools all the normal things that are used in the workshop, Files, screwdrivers, hammer, pliers etc.

Consumables
Sand paper in various grades from rough to fine.
Acetone
Dry Film Lubricant in a spray can for the gears after everything is finished.

Clock 29 FDM - Materials

For all the Plastic Parts I used ABS

Mostly you will require one of each of the STL parts, but the following parts will require multiples listed below

Wall Spacer	3
Pulley Sleeve	2
Inside Spacer	5
Pawl	4
60 Tooth Gear	3
15 Tooth Gear	3
8 Tooth Gear	2
Sprocket	3
Screw	4

For all the other parts

Ø2 mm Silver Steel 600 mm long
Ø15 Brass x 30mm long

Ø9.5 mm Balls approx. 300
WoodscrewsØ4.5x60mm 2 required

Cord 3 meter of Ø0.5mm cord or fishing line.
If you can't find the sizes I have used you can easily modify the design to suit what you can find.

Note these are the minimum amounts of material necessary to build the clock I used more in the prototype and you may well be advised to by extra to cover those accidental losses that occur.
If I have missed anything here you will find them in the parts list for the clock anyway.

Clock 29 FDM- Hints and Tips-1

1 Silver steel is common tool steel that is supplied as a centreless ground round bar (with tolerances similar to that of drill rod). The name comes from the highly polished appearance of the rods. The American equivalent is tools steel or Drill Rod. Typical American supplier is www.speedymetals.com/ps-3356-17-2532-rd-o-l -drill-rod.aspx. The nearest equivalent to the Ø2 mm used for this project is Ø 5/64".

2 To enable you to modify the models I have supplied IGS or STP files for all of the parts which should be easier to modify than the original STL. See this web page for a list of suitable CAD programs, several of which are free http://alternativeto.net/software/freecad/

3 The Cross section drawing in the instructions shows the types of fit needed for all the moving parts in the clock, it is recommended that these fits be achieved by drilling the holes formed in the printed parts using drill sizes given in the chart below. For the metric build use ØI .9mm for tight fit and Ø2.1 for a loose fit.

4

Drill size	Diameter (in)	Diameter (mm)
#49	0.0730	1.8542
1.9 mm	0.0748	1.9000
#48	0.0760	1.9304
5/64 in	0.0781	1.9844
#47	0.0785	1.9939
2 mm	0.0787	2.0000
#46	0.0810	2.0574
#45	0.0820	2.0828
2.1 mm	0.0827	2.1000
#44	0.0860	2.1844

5 I used Ø8 mm steel balls (Catapult Ammo) for the Main weight 400gms and the Counter weight 10gms, but you can of course use any heavy metal to serve this purpose. The main weight container is a little large deliberately as the running weight was unknown at the time it was modelled so you may want to make it a little smaller

6 1 used ABS throughout for this model and it has worked well, I won't try to advice on the settings for your printers as I only have experience of the Zortrax printer, and I am sure you are more experienced at this than I am.

7 The cord used is 1500mm long for the weight and 1500mm for the counter weight, I used 0.5mm red fishing cord, the advantage of this cord is that it doesn't twist when loaded.

8 To bond together the plastic parts together I use a liquid solvent adhesive applied with a syringe like applicator or if necessary a small brush, this latter can be a bit messy.

10 The clock is fitted with a gravity ratchet comprising 4 Pawls placed around the ratchet on the drum, so that at any position two pawls will always engage.
To wind the clock simply pull down on the counterweight cord repeatedly until the main weight reaches its highest possible position.

11 Many of the parts have been split into 2 or more components to reduce the need to add supports during the printing of the part. Liquid solvent bonding is used to glue all the necessary parts together.
I printed the dial in 2 colours as the machine I was using (Zortrax) although not fitted with two printing heads allowed printing to be paused and the filament changed. If you can't do that then you will need to paint the top face of the up-standing numerals.
I have sized the parts mainly so that the small holes come out under size to allow you to drill out the part to get the correct fit. You are going to need tight and loose fits at different points in the assembly so you will need to have Ø1.9mm Ø2mm and Ø2.1mm drills. In the case of the bearings the holes are sized to give a press fit, so you may need to adjust that for your printer.

12 The gears should be positioned on the shafts so they line up with the mating gears, the dimensions given on the instructions should be used as a starting point to achieve this.

13 Clean up all the gears to make sure they are burr and swarf free. All the gears should run absolutely smoothly when assembled into the frames, check by slowly turning the first driving gear and feel for any restrictions, if you find one track it down and remove them with sharp knife blade, and continue till the all run freely.
If the clock keeps stopping in the same place or places, then there is still a restriction in there somewhere, as a last resort assemble the clock without the escapement in place, add the weight an let it run down to the floor, repeat several times and the retry running fully assembled, it will then hopefully work.

14 To set the clock up initially adjust the Balance weights to the ends of the shaft and adjust one or the other in or out to get the finger protruding from the bottom of the Balance wheel to be just touching the side of the impulse pin. Give the balance weight a slight nudge downwards and then adjust the balance weight at the other side until the clock ticks evenly.

To adjust the time, move both weights in or out together in small increments to speed up or slow down the clock.
Pushing the weights inwards slows it down and visa versa.

15 For a description of how the Gravity Escapement works with the Balance Wheel and Spring see
http://brianlawswoodenclocks.blogspot.co.uk/2016/08/using-balance-wheel-and-spring-to.html