Fermi-Dirac Distribution

In[41]:=
```
Clear["Global`*"]
```

Use the Fermi-Dirac distribution.

In[42]:=
```
nFD[ϵ_, μ_, T_] := 1 / (Exp[(ϵ - μ) / (k T)] + 1) // Quiet
```

The chemical potential can by found by the normalization condition, $N = \int_0^\infty n(E)\, dE$. For a typical free electron gas model of a conductor, a value of 5 eV is reasonable. Use that for an illustrative graph. For extreme ranges, Mathematica issues warnings about loss of precision. We will ignore them here since they don't impact our qualitative results here.

In[43]:=
```
k = QuantityMagnitude[
  UnitConvert[Quantity[1., "BoltzmannConstant"], "Electronvolts" / "Kelvins"]]
 (* Boltzmann's Constant in eV/K *)
```

Out[43]=
```
0.0000861733
```

In[44]:=
```
μ = 5.00; (* in eV *)
```

This plot shows the FD distribution for different temperatures, and keeps the very-low temperature graph on for comparison.

In[45]:=
```
N[nFD[5, μ, 1]]
```

Out[45]=
```
0.5
```

In[52]:=
```
Manipulate[Plot[{nFD[ϵ, μ, 0.1], nFD[ϵ, μ, T]}, {ϵ, 0, 10},
   LabelStyle → Larger, AxesLabel → {"ϵ (eV)", "nFD"},
   PlotLegends → {"Low T", StringForm["T = `` (K)", T]},
   PlotRange → {{0, 10}, {0, 1}}, ImageSize → Scaled[0.7]] // Quiet,
 {T, 10, 10000, Appearance → "Open"}]
```

Out[52]=