# Problem 1 (Peskin 14.2)

In[1]:=
```
<< Notation`
```

In[2]:=
```
Symbolize[ αs ]; Symbolize[ αs0 ]; Symbolize[ Q0 ]; Symbolize[ b0 ]; Symbolize[ nf ];
Symbolize[ m0 ]; Symbolize[ mf ]; Symbolize[ mu ]; Symbolize[ md ];
Symbolize[ ms ]; Symbolize[ mc ]; Symbolize[ mt ]; Symbolize[ mb ];
```

In[4]:=
```
$Assumptions = {Q > 0};
```

In[5]:=
```
mu = 0.0022;
md = 0.0047;
ms = 0.096;
mc = 1.28;
mb = 4.18;
mt = 164;
```

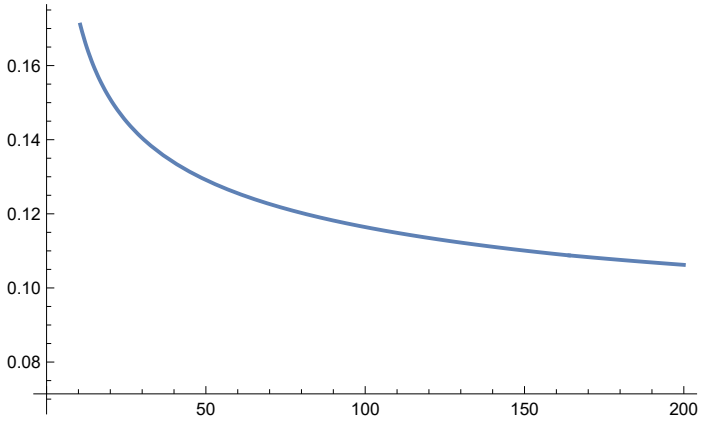
In[11]:=
```
b0 = 11 - 2/3 nf;

f[q_, q0_, α0_] := α0 / (1 + (b0 α0 / (2 π)) Log[q / q0]);

αs[Q_] := Piecewise[{{f[Q, mt - 1, αs[mt - 1]] /. nf → 6, mt < Q},
    {f[Q, 91, 0.118] /. nf → 5, mb ≤ Q < mt},
    {f[Q, mb, αs[mb]] /. nf → 4, mc ≤ Q < mb}, {f[Q, mc, αs[mc]] /. nf → 3,
     ms ≤ Q < mc}, {f[Q, ms, αs[ms]] /. nf → 2, md ≤ Q < ms},
    {f[Q, md, αs[md]] /. nf → 1, mu ≤ Q < md}, {f[Q, mu, αs[mu]] /. nf → 0, Q < mu} }];
```

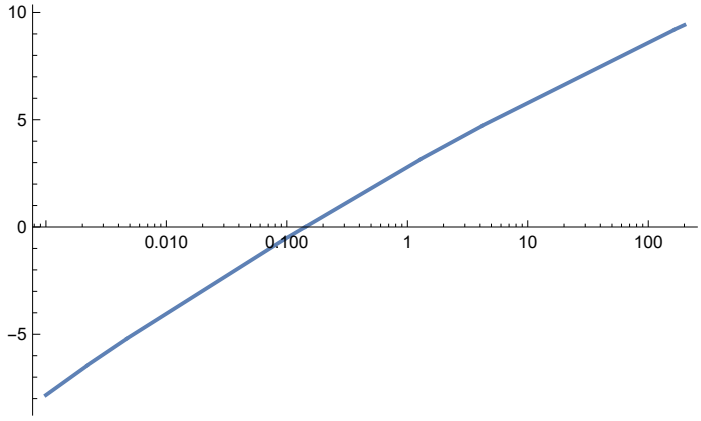
In[14]:=
```
Plot[αs[Q], {Q, 0.001, 200}]
```

Out[14]=



In[15]:=
```
LogLinearPlot[1/αs[Q], {Q, 0.001, 200}]
```

Out[15]=




## a)

In[16]:=
```
αs[mb]
```

Out[16]=
```
0.212056
```

In[17]:=
```
αs[2]
```

Out[17]=
```
0.26752
```

In[18]:=
```
αs[mc]
```

Out[18]=
```
0.317851
```

## b)

```
m[Q_, m0_, Q0_] := m0 (αs[Q]/αs[Q0])^(4/b0)
```

## c)

In[32]:=
```
m[2, mc, mc] /. nf → 4
```

Out[32]=
```
1.17835
```

# d)

In[38]:=
```
n_f = 5;
m[m_b, m_u, 2]
m[m_b, m_d, 2]
m[m_b, m_s, 2]
m[m_b, m_c, 1.28]
```

Out[39]=
```
0.00197001
```

Out[40]=
```
0.00420866
```

Out[41]=
```
0.0859641
```

Out[42]=
```
1.05772
```