Q2

$$P_0 = e^{-rT}E[(K - S_0 e^{\left(r-\frac{\sigma^2}{2}\right)T+\sigma\sqrt{T}\times z})^+]$$

$$S_T < K \Leftrightarrow z \leq -d_2$$

$$E\left[\left(K - S_0 e^{\left(r-\frac{\sigma^2}{2}\right)T+\sigma\sqrt{T}\times z}\right)^+\right] = \int_{-\infty}^{-d_2} K - S_0 e^{\left(r-\frac{\sigma^2}{2}\right)T+\sigma\sqrt{T}\times x}\frac{1}{\sqrt{2\pi}}e^{-\frac{x^2}{2}}dx$$

$$= K\int_{-\infty}^{-d_2}\frac{1}{\sqrt{2\pi}}e^{-\frac{x^2}{2}}dx - S_0 e^{rT}\int_{-\infty}^{-d_2}\frac{1}{\sqrt{2\pi}}e^{\left(-\frac{\sigma^2}{2}\right)T+\sigma\sqrt{T}\times x-\frac{x^2}{2}}dx$$

$$= K\Phi(-d_2) - S_0 e^{rT}\int_{-\infty}^{-d_2}\frac{1}{\sqrt{2\pi}}e^{-\frac{(x-\sigma\sqrt{T})^2}{2}}dx$$

$$= K\Phi(-d_2) - S_0 e^{rT}\int_{-\infty}^{-d_2-\sigma\sqrt{T}}\frac{1}{\sqrt{2\pi}}e^{-\frac{y^2}{2}}dy = K\Phi(-d_2) - S_0 e^{rT}\int_{-\infty}^{-d_1}\frac{1}{\sqrt{2\pi}}e^{-\frac{y^2}{2}}dy$$

$$= K\Phi(-d_2) - S_0 e^{rT}\Phi(-d_1)$$

$$P_0 = e^{-rT}\,K\Phi(-d_2) - S_0\Phi(-d_1)$$

$$\frac{\partial P(S_0,0)}{\partial S_0} = e^{-rT}\,K\frac{n(-d_2)}{S_0\sigma\sqrt{T}} - \frac{S_0 n(d_1)}{S_0\sigma\sqrt{T}} - \Phi(-d_1) = \frac{e^{-rT}\frac{K}{S_0}n(-d_2) - n(-d_1)}{S_0\sigma\sqrt{T}} - \Phi(-d_1)$$

$$= -\Phi(-d_1)$$

Q3

Price of the Call 32.3250

Price of the Put 30.9625

Price of Forward contract 1.3625=32.3250-30.9625

```
function x=call(F,K,T,sig,r)
        if T*sig == 0
            x=max(F-K,0);
            return;
        end
        d1=log(F/K)+0.5*(sig^2)*T;
        d1=d1/(sig*sqrt(T));
        d2=d1-sig*sqrt(T);
        nd1=0.5*(1+erf(d1/sqrt(2)));
        nd2=0.5*(1+erf(d2/sqrt(2)));
        x=F*nd1-exp(-r*T)*K*nd2;
        return;
```

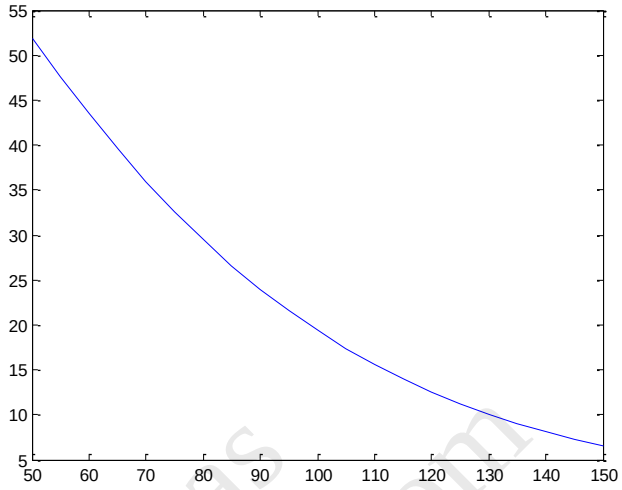
```
function x=put(F,K,T,sig,r)
        if T*sig == 0
            x=max(K-F,0);
            return;
        end
        d1=log(F/K)+0.5*(sig^2)*T;
        d1=d1/(sig*sqrt(T));
        d2=d1-sig*sqrt(T);
        nd1=0.5*(1+erf(-d1/sqrt(2)));
        nd2=0.5*(1+erf(-d2/sqrt(2)));
        x=exp(-r*T)*K*nd2-F*nd1;
        return;
```

Q4

```
sig=0.47;
F=100; T=1;
```

```
dK=5;
K=50:dK:150; CP=zeros(size(K));
DCF=0.98;
for i=1:length(K)
    Ki=K(i);
    CP(i)=call2(F,Ki,T,sig,DCF);
end
plot(K,CP)

    function x=call2(F,K,T,sig,DCF)
    if T*sig == 0
        x=max(F-K,0);
        return;
    end
    d1=log(F/K)+0.5*(sig^2)*T;
    d1=d1/(sig*sqrt(T));
    d2=d1-sig*sqrt(T);
    nd1=0.5*(1+erf(d1/sqrt(2)));
    nd2=0.5*(1+erf(d2/sqrt(2)));
    x=F*nd1-DCF*K*nd2;
    return;
```




```
for i=1:length(K)
    Ki=K(i);
    PP(i)=put2(F,Ki,T,sig,DCF);
end
plot(K,PP)

    function x=put2(F,K,T,sig,DCF)
    if T*sig == 0
        x=max(K-F,0);
        return;
    end
    d1=log(F/K)+0.5*(sig^2)*T;
    d1=d1/(sig*sqrt(T));
    d2=d1-sig*sqrt(T);
    nd1=0.5*(1+erf(-d1/sqrt(2)));
    nd2=0.5*(1+erf(-d2/sqrt(2)));
    x=DCF*K*nd2-F*nd1;
    return;
```