1.1

1)

spot price yields 5050*exp(0.035*1)=5229 at maturity.

Yes, there's an arbitrage opportunity. Borrow $5050 from the money market, buy 1 ounce of gold by entering a long position of the contract at $5200. At maturity, we will receive a profit of 5229-5200=$29

2)

Yes, there's an arbitrage opportunity. Borrow $5050 from the money market and buy 1 ounce of gold at spot price. Then enter a short position of the contract at $5300. At maturity, we will receive a profit of 5300-5229=$71

1.2

1)

$R2 = m2*[(1+R1/m1)^(m1/m2)-1]$

If it's annual compounding, $m1=2$, $R1=0.0325$, $m2=1$

$R2 = 0.0327$

2)

If it's quarterly compounding, $m1=2$, $R1=0.0325$, $m2=4$

$R2=0.0323$

3)

If it's quarterly compounding, $Rc = m*\ln(1+Rm/m)$

$Rm=0.0325$, $m=2$

$Rc = 0.0322$

```
import numpy
y=(1+0.0325/2)**(2)-1
y
```

```
0.0327640625000003
```

```
y=(1+0.0325/2)**(1/2)-1
y=y*4
y
```

```
0.03236903073119102
```

```
y=2*math.log(1+0.0325/2)
y
```

```
0.03223876375976678
```

1.3

A=10000, n=30/365, R = 0.01715

A1 = A*exp(R*n)=10141.96

1.4

FV = 100

1)

Bond1 = FV*0.05/2*(exp(-0.03*0.5)+exp(-0.03*1)+exp(-0.035*1.5))+(FV+FV*5%/2)*exp(-0.035*2) = 102.83

2)

Bond2 = FV*0.06/2*(exp(-0.03*0.5)+exp(-0.03*1)+exp(-0.035*1.5)+exp(-0.035*2)+exp(-0.0425*2.5)+…+exp(-0.0425*5)+exp(-0.045*5.5)+…+exp(-0.045*9.5))+(FV+FV*0.06/2)*exp(-0.045*10) = 111.8428

3)

FV*0.05/2*(exp(-y1*0.5)+exp(-y1*1)+exp(-y1*1.5))+(FV+FV*5%/2)*exp(-y1*2) = 102.83

Y1=0.0349

Replace all the zero rates with y2 in the second question of the problem we'll get y2 = 0.0447

```
y = 2.5 *(math.exp(-0.03*0.5)+math.exp(-0.03)+math.exp(-0.035*1.5))+102.5*math.exp(-0.07)
y

102.83139602587813
```

```
from scipy.optimize import root
f = lambda x: 2.5*(math.exp(-0.5*x)+math.exp(-x)+math.exp(-1.5*x))+102.5*math.exp(-2*x)-102.83
sol = root(f,0)
print(sol.x[0])

0.034915034740735755
/tmp/ipython-input-2396133106.py:2: DeprecationWarning: Conversion of an array with ndim > 0 to a
  f = lambda x: 2.5*(math.exp(-0.5*x)+math.exp(-x)+math.exp(-1.5*x))+102.5*math.exp(-2*x)-102.83
```

| | | | |
|---|---|---|---|
| 0.5 | 3 | 0.03 | 2.955336 |
| 1 | 3 | 0.03 | 2.911337 |
| 1.5 | 3 | 0.035 | 2.846563 |
| 2 | 3 | 0.035 | 2.797181 |
| 2.5 | 3 | 0.0425 | 2.697599 |
| 3 | 3 | 0.0425 | 2.64088 |
| 3.5 | 3 | 0.0425 | 2.585354 |
| 4 | 3 | 0.0425 | 2.530994 |
| 4.5 | 3 | 0.0425 | 2.477778 |
| 5 | 3 | 0.0425 | 2.425681 |
| 5.5 | 3 | 0.045 | 2.342251 |
| 6 | 3 | 0.045 | 2.290138 |
| 6.5 | 3 | 0.045 | 2.239186 |
| 7 | 3 | 0.045 | 2.189367 |
| 7.5 | 3 | 0.045 | 2.140656 |
| 8 | 3 | 0.045 | 2.093029 |
| 8.5 | 3 | 0.045 | 2.046462 |
| 9 | 3 | 0.045 | 2.00093 |
| 9.5 | 3 | 0.045 | 1.956412 |
| 10 | 103 | 0.045 | 65.6757 |
| | | | 111.8428 |
| | | | |
| | | | 0.04465 |
| | | | 111.8428 |

1.5

1)

Locked in paying 1mil*1.15=1.15mil

Without hedging 1mil*1.175=1.175mil

Gain 1.175-1.15 =0.025mil

2)

$Rf = R*\exp[(rUSD-rEUR)*t]$

$Rf = 1.15$, $R = 1.1$, $t=0.5$

$rUSD-rEUR = 0.0889$