CIS*2460 Assignment 2
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Question 1
The following is a scan of my proof.

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Question 1

Prove $V(aX+bY+c)=a^2V(X)+b^2V(Y)+2ab\,COV(x,y)$
Where X,Y are two different random variables with $\{\mu_X,\sigma_X^2\},\{\mu_Y,\sigma_Y^2\}$ as mean & variance of X,Y.
and $COV(X,Y)=E((X-\mu_X)(Y-\mu_Y))$

$$
\begin{aligned}
V(aX+bY+c) &= E(((aX+bY+c)-E(aX+bY+c))^2)\\
&=E((aX+bY+c-aE(X)-bE(Y)-c)^2)\\
&=E((aX+bY-aE(X)-bE(Y))^2)\\
&=E((aX+bY-a\mu_X+b\mu_Y)^2)\\
&=E((a(X-\mu_X)+b(Y-\mu_Y))^2)\\
&=E(a^2(X-\mu_X)^2+2ab(X-\mu_X)(Y-\mu_Y)+b^2(Y-\mu_Y))\\
&=a^2E((X-\mu_X)^2)+2ab\,E((X-\mu_X)(Y-\mu_Y))+b^2E((Y-\mu_Y)^2)\\
&=a^2V(X)+2ab\,COV(X,Y)+b^2V(Y)\\
&=a^2V(X)+b^2V(Y)+2ab\,COV(X,Y)\quad\blacksquare
\end{aligned}
$$

Question 2
a)

a = 2,814,767,109
c = 59,482,661,568,307
m=2^{48}
GCD(a, b) = 1
Since m is a power of two, but c is nonzero, P=m
Since a,c are relatively prime, max period P is achieved.

b)

a = 69,069

c = 0
m=2^{32}
Since m is a power of two but c is zero, P=m/4=2^{30}
Since a is of form 5+8k where k=8633, the max period P is achieved

c)

a = 4951
c = 247
m = 256 = 2^8
Since m is a power of two but c is nonzero, thus P=m
Since a,c are relatively prime, max period P is achieved.

d)

a=6507
c=0
m=1024=2^{10}
Since m is a power of two but c is zero, thus P=m/4=2^8
Since a is of form 3+8k where k=813 the max period P is achieved

Question 3

The following are a result of running through each generator described in Chapter 7, Question 15 in the text.

A (**15a**)	M	X_{ii}
11	16	7
		13
		15
		5
		7
		13
		15
		5
		7
		13
		15
		5
		7
		13
		15
		5
		7
		13
		15

A (**15c**)	M	X_{ii}
7	16	7
		1
		7
		1
		7
		1
		7
		1
		7
		1
		7
		1
		7
		1
		7
		1
		7
		1
		7

A (**15b**)	M	X_{ii}
11	16	8
		8
		8
		8
		8
		8
		8

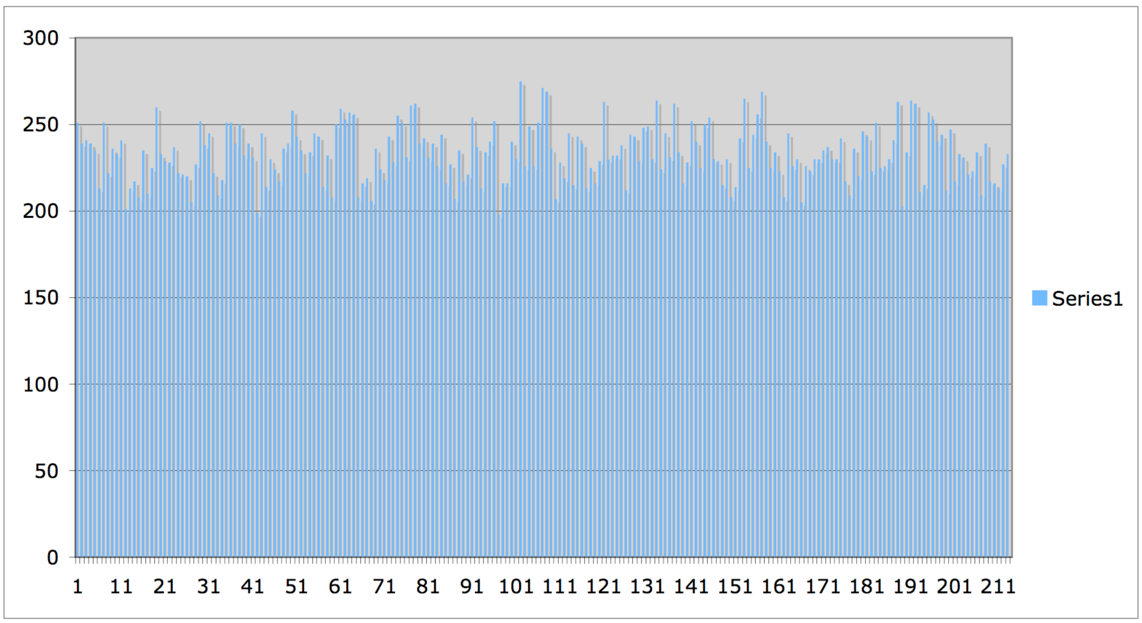
A (**15d**)	M	X_{ii}
7	16	8
		8
		8
		8
		8
		8
		8

8	8
8	8
8	8
8	8

Examining each part., we note that 15a has a period of 3. 15b has a period of 1. 15c has a period of 2. 15d has a period of 1.

Question 4

My submission makes use of a combined linear congruental pseudorandom number generator. Instructions on how to compile and use the `libsimrand.a` library and run the demonstration are in the readme.txt. The results of my demonstration have yielded the following histogram, from coming up with 50,000 random numbers with my generator.



The x-axis are the buckets of numbers, each of which are size 10,000,000. And the y-axis is the frequency of each bucket value range.

As we can see, the resulting values are fairly uniformly distributed. It has a bit of difference between its high and low values, but with a bit of tuning to the multipliers and maxima it could be a tad more uniform. The multipliers and maxima used are listed in the source code.