

10. MATLAB Problem:

a)

```
trials = 10000;
X = zeros(trials);
Y = zeros(trials);
XY = zeros(2,2);

for k=1:trials
    val = rand(1);
    if(val <= 1/8)
        X(k) = 0;
        Y(k) = 0;
        XY(1,1) = XY(1,1)+1;
    elseif(val <= 1/4)
        X(k) = 1;
        Y(k) = 0;
        XY(1,2) = XY(1,2)+1;
    elseif(val <= 1/2)
        X(k) = 0;
        Y(k) = 1;
        XY(2,1) = XY(2,1)+1;
    else
        X(k) = 1;
        Y(k) = 1;
        XY(2,2) = XY(2,2)+1;
    end
end

XY = XY ./ trials;
```

Results		
	x = 0	x = 1
y = 0	.1291	.1236
y = 1	.2489	.4984

b)

```
pX_x_0 = sum(XY(:,1));%from previous method
pX_x_1 = sum(XY(:,2));%from previous method
Y_x_0 = zeros(trials,1);
Y_x_1 = zeros(trials,1);
Y_0 = zeros(2,1);
Y_1 = zeros(2,1);
XY_2 = zeros(2,2);

for m=1:trials
    val2 = rand(1);
    %x=0
    if(val2 <= 1/3)
        Y_x_0(m) = 0;
        Y_0(1) = Y_0(1)+1;
    else
        Y_x_0(m) = 1;
        Y_0(2) = Y_0(2)+1;
    end
    %x=1
```

Results		
	x = 0	x = 1
y = 0	.1251	.1207
y = 1	.2529	.5013

```

    if(val2 <= 1/5)
        Y_x_1(m) = 0;
        Y_1(1) = Y_1(1)+1;
    else
        Y_x_1(m) = 1;
        Y_1(2) = Y_1(2)+1;
    end
end

Y_0 = Y_0 ./ trials .* pX_x_0;
Y_1 = Y_1 ./ trials .* pX_x_1;

XY_2 = [Y_0 Y_1];

```

c)

$$E(X) = \sum x p_x(x) = 0*(3/8) + 1*(5/8) = \boxed{5/8 = .625}$$

Simulated averages:

$$\text{Method 1) Avg} = 0*(.1291+.2489) + 1*(.1236+.4984) = \boxed{.622}$$

$$\text{Method 2) Avg} = 0*(.1251+.2529) + 1*(.1207+.5013) = \boxed{.622}$$

These values match fairly closely.

d)

$$\text{var}(X) = E(X^2) - (E(X))^2 = (0^2*(3/8) + 1^2*(5/8)) - (.625)^2 = \boxed{15/64 = .2344}$$

Simulated variances:

$$\text{Method 1 \& 2) Var}(X) = (0 + 1^2*(.622)) - (.622)^2 = \boxed{.2351}$$

These values are also very close to the analytical ones.