Answer 2

```
% HARSHIT RAI
% 2017152

%%
% Message signal
clear all;
clc;

fs=200*1000; % Sampling frequency of original signal : almost continuous
ts=1/fs;
n=1000;     % Generate 1000 cycles
t= 0:ts:n*ts-ts ;  % From 0 to ts in step of (n*ts-ts)

fm=1*1000;  % Frequency of message signal
tm=1/fm;
am=2;  % Amplitude of message signal
mt=am*sin(2*pi*fm*t);  % Message signal

subplot(2,1,1)
plot(t,mt)
title('Message Signal')
xlabel('Time axis');
ylabel('Amplitude');
hold on;

%%
% Phase modulated signal

fc=6.5*1000;  % Frequency of carrier signal
tc=1/fc;
kp=pi/2;  % Phase modulation index
ac=1;  % Amplitude of carrier signal
pt=ac*sin((2*pi*fc*t)+(kp*mt));  % Phase modulated signal

subplot(2,1,2)
```

```
plot(t,pt)
title('Phase modulated signal')
xlabel('Time axis');
ylabel('Amplitude');
hold on;
```

<u>Answer 1</u>

A) If quantization levels are increased, then the quantization error decreases. Because they are inversely proportional.

Error=(2*Amplitude) / (L)

B) If sampling frequency is increased, then the quantization error decreases. Because now more number of samples are recorded and therefore error also gets decreased.

CODE

```
% HARSHIT RAI
% 2017152

%%
% Input Sinusoid
clear all;
clc;

fm=1*1000; % Message signal frequency
tm=1/fm;

fs=250*1000; % Sampling frequency of original signal : almost continuous
ts=1/fs;

n=5; % Generate 5 cycles
```

```
a=2; % Amplitude of sinusoid
t= 0 : ts : (n*tm-ts) ; % From 0 to ts in step of (n*tm-ts)

mt=a*sin(2*pi*fm*t);  % Analog Input Signal

subplot(3,1,1);
plot(t,mt);
title('Analog Input Signal');
xlabel('Time');
ylabel('Amplitude');

%%
% Sampling

fs1=20*1000;   % Sampling frequency
ts1=1/fs1;
t1= 0 : ts1 : (n*tm-ts1) ; % Time index
mt1=a*sin(2*pi*fm*t1);

subplot(3,1,2);
plot(t,mt);
title('Sampled Signal');
xlabel('Time');
ylabel('Amplitude');
hold on;
stem(t1,mt1);

%%
%Quantisation

bit=3; % Quantization bit for 8 levels
l=2^bit;
del=2*a/l; % Step size

samples=length(mt); % Total number of samples
levels=zeros(1,samples); % Array for quantization levels
error=zeros(1,samples);   % Array for quantization error

up=a-del/2; % Maximum voltage
down=-a+del/2; % Minimum voltage

%In the below "for loop" we are mapping the sample values to their quantization levels
```

```
for h=down:del:up % Iterating from lowest to the highest level
   for r=1:samples % For all samples
      % If the sample value lies within the range -del/2 < sample < del/2
      if(((h-del/2)<mt(r))&&(mt(r)<(h+del/2)))
         levels(r)=h;
         error(r)=mt(r)-h;    % Error= Actual value - apparent value
      end
   end
end

subplot(3,1,3);
plot(t,levels,t1,mt1);
title('Quantized Signal');
xlabel('Quantization intervals');
ylabel('Quantization levels');

%%
% Code generator

codegenerator=zeros(1,samples);  % Array for binary code generator

for p=2:samples % For all samples
   if(levels(p)==down+(0*del))
      codegenerator(p)=000;
   end
   if(levels(p)==down+(1*del))
      codegenerator(p)=001;
   end
   if(levels(p)==down+(2*del))
      codegenerator(p)=010;
   end
   if(levels(p)==down+(3*del))
      codegenerator(p)=011;
   end
   if(levels(p)==down+(4*del))
      codegenerator(p)=100;
   end
   if(levels(p)==down+(5*del))
      codegenerator(p)=101;
   end
   if(levels(p)==down+(6*del))
      codegenerator(p)=110;
   end
```

```
    if(levels(p)==down+(7*del))
        codegenerator(p)=111;
    end

end

%%
% Quantization error

display(error);
```