Answers:

Q1:

Part a)

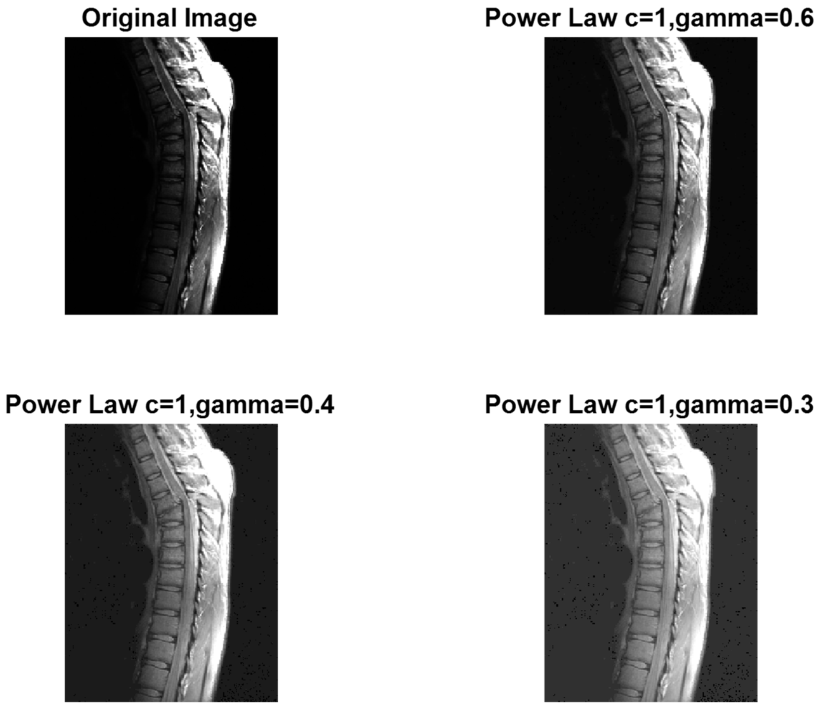

Figure 1

When we increase the gamma from 0.3 to 0.6, we eliminate some distortions, but we lose some part of visible part of the image. Contrast is getting increased while we are increasing the gamma. I prefer image with gamma=0.4 one among others (Figure 1).

```
img1=im2double(imread("Fig3.08(a).jpg"));
power_law=@(c,r,gamma) real(c.*(r.^gamma));
out_img1_06=power_law(1,img1,0.6);
out_img1_04=power_law(1,img1,0.4);
out_img1_03=power_law(1,img1,0.3);

figure;subplot(221);imshow(img1);title("Original Image");subplot(222);
imshow(out_img1_06);title("Power Law c=1,gamma=0.6");
subplot(223);imshow(out_img1_04);title("Power Law c=1,gamma=0.4");
subplot(224);imshow(out_img1_03);title("Power Law c=1,gamma=0.3");
```

Part b)

i)

Figure 2

We can see that image has some blur and not sharp enough (Figure 2).

```
a=im2double(imread("Fig3.46(a).jpg"));
figure;imshow(a);title("Original Image (a)");
```

ii)

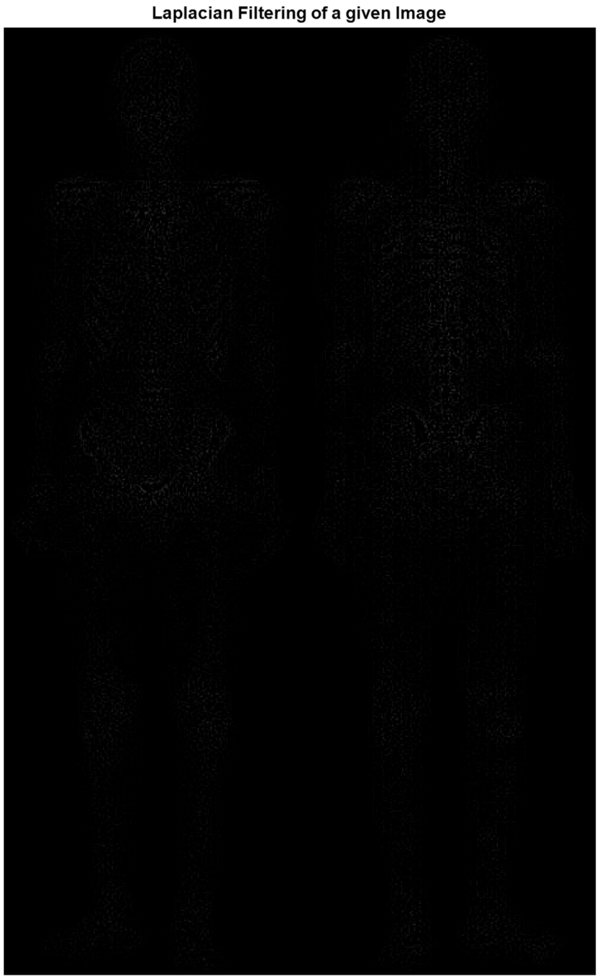

Figure 3

Result of the Laplacian filter is not easy to see as an image (Figure 3).

```
H_laplacian=fspecial('laplacian');b=imfilter(a,-H_laplacian);
figure;imshow(b);title("Laplacian Filtering of a given Image");
```

iii)

Figure 4

I see noticeable difference between original and sharpened image (Figure 4).

```
c=a+b;
figure;imshow(c);title("Sharpened Image");
```

iv)

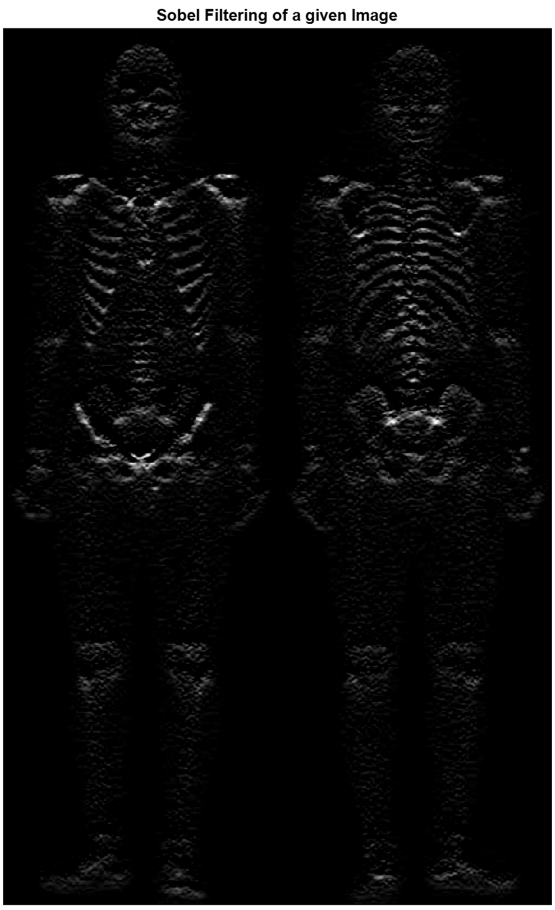

Figure 5

We can see that edges of the original image can be seen in Figure 5 as expected from result of Sobel filtering.

```
H_sobel=fspecial('sobel');
d=imfilter(a,H_sobel);
figure;imshow(d);title("Sobel Filtering of a given Image");
```

v)

Figure 6

We can see that the edges of the Sobel filtered image has been smoothed after averaging filter which is nothing but low pass (smoothing) filter (Figure 6).

```
H_averaging=fspecial('average',[5,5]);
e=imfilter(d,H_averaging);
figure;imshow(e);title("Averaging Filtering of a given Image");
```

vi)

Figure 7

As we can see in Figure 7 we get a mask image which is consist of common pixel intensity values between sharpened image and smoothed and Sobel filtered image.

```
f=c.*e;
figure;imshow(f);title("Mask of a given Image by product of c and
e");
```

vii)

Figure 8

We get sharper image than part iii. The blur on the image at part iii has been eliminated nearly completely if we compare the two images part iii and part vii (Figure 8).

```
g=a+f;
figure;imshow(g);title("Sharpened Image by summation of a and f");
```

viii)

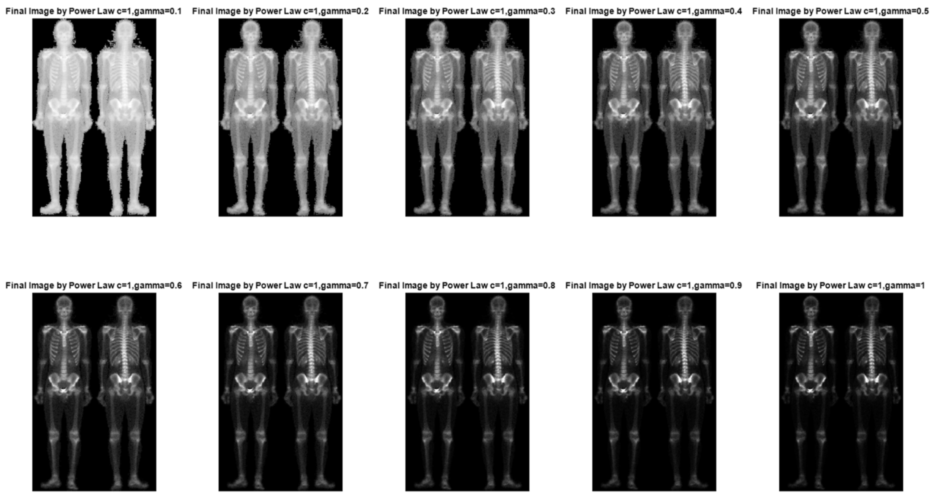

Figure 9

We can see that while we are increasing gamma from 0.1 to 1, we get better bone structure image and, we eliminate distortions, but we lose body shape at the same time. I would choose the image with gamma = 0.8 or 0.7, but if I wanted to see bone structure clearly but if I need to see body shape also, then I would choose the image with gamma = 0.5.

```
h=power_law(1,g,0.5);
figure;
subplot(251)imshow(power_law(1,g,0.1));title("Final Image by Power Law c=1,gamma=0.1");
subplot(252)imshow(power_law(1,g,0.2));title("Final Image by Power Law c=1,gamma=0.2");
subplot(253)imshow(power_law(1,g,0.3));title("Final Image by Power Law c=1,gamma=0.3");
subplot(254)imshow(power_law(1,g,0.4));title("Final Image by Power Law c=1,gamma=0.4");
subplot(255)imshow(power_law(1,g,0.5));title("Final Image by Power Law c=1,gamma=0.5");
subplot(256)imshow(power_law(1,g,0.6));title("Final Image by Power Law c=1,gamma=0.6");
subplot(257)imshow(power_law(1,g,0.7));title("Final Image by Power Law c=1,gamma=0.7");
subplot(258)imshow(power_law(1,g,0.8));title("Final Image by Power Law c=1,gamma=0.8");
subplot(259)imshow(power_law(1,g,0.9));title("Final Image by Power Law c=1,gamma=0.9");
subplot(2,5,10)imshow(power_law(1,g,1));title("Final Image by Power Law c=1,gamma=1");
```

ix)

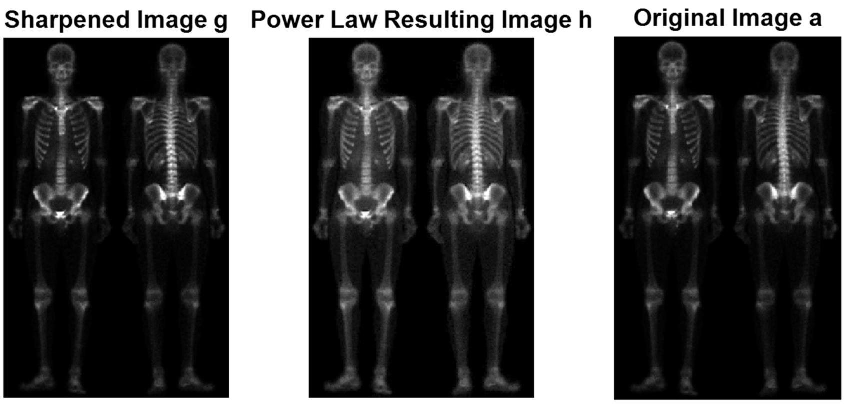

Figure 10

We cannot separate original image (a) and Sharpened image (g) just look at them, but we can separate Power Law resulting image with others by simply looking them. Bones can be seen much better in image h than both images (a) and (g). I would choose h which has gamma as 0.7 (Figure 10).

```
figure;
subplot(131);imshow(g);title("Sharpened Image g");
subplot(132);imshow(h);title("Power Law Resulting Image h");
subplot(133);imshow(a);title("Original Image a");
```

Question 2

Homomorphic filtering is a filtering Technique which is used to enhance images with low brightness (illumination).

The block diagram can be seen below in Figure 11.

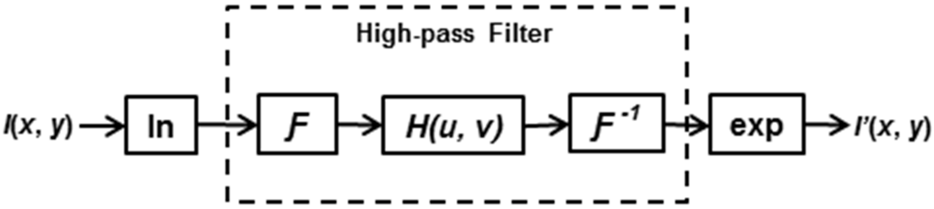

Figure 11

First step is taking natural logarithm of each pixel.

Second step is taking 2 dimensional FFT of the image to apply filter in Frequency domain

Third step is applying High Pass Filter to an image (which is usually created by (1-Lp(H)))

Fourth step is taking 2 dimensional Inverse FFT to get back in the time domain to printing image.

Fifth step is taking exponential of each pixel.

Since the PET imaging technique is using special radiotracer fluids to enhance visualization of a body, we need to remove low illumination problem. So, we can use Homomorphic filtering for this problem.

We have 2 variables to change which are Sigma and const.

The code has been given below:

```
I=im2double(imread("Fig0462(a)(PET_image).tif"));
% Get ln of Image
I = log(1 + I);
% Get M, N for FFT
[M,N] = size(I);
% High Pass Filter
sigma = 20;
const=1;
Gamma_h=3.0;
Gamma_l=0.4;
p=M/2;
```

```
q=N/2;
H=zeros(M,N);
for i=1:M
for j=1:N
distance=sqrt((i-p)^2+(j-q)^2);
H(i,j)=(Gamma_h-Gamma_l)*(1-exp((-
const*(distance)^2)/((2*sigma^2))))+Gamma_l;
end
end
% Centering Filter Response
H = fftshift(H);
% FFT
If = fft2(I, M, N);
% Filtering Then Taking Inverse FFT
Iout = real(ifft2(H.*If));
Iout = Iout(1:size(I,1),1:size(I,2));
% Taking Inverse Logarithm
Ihmf = exp(Iout) - 1;
% display the images
figure;imshowpair(I, Ihmf, 'montage');title("Original image vs Enchanced
image");
```

For sigma = 20 and const=1 we get result in Figure 12.

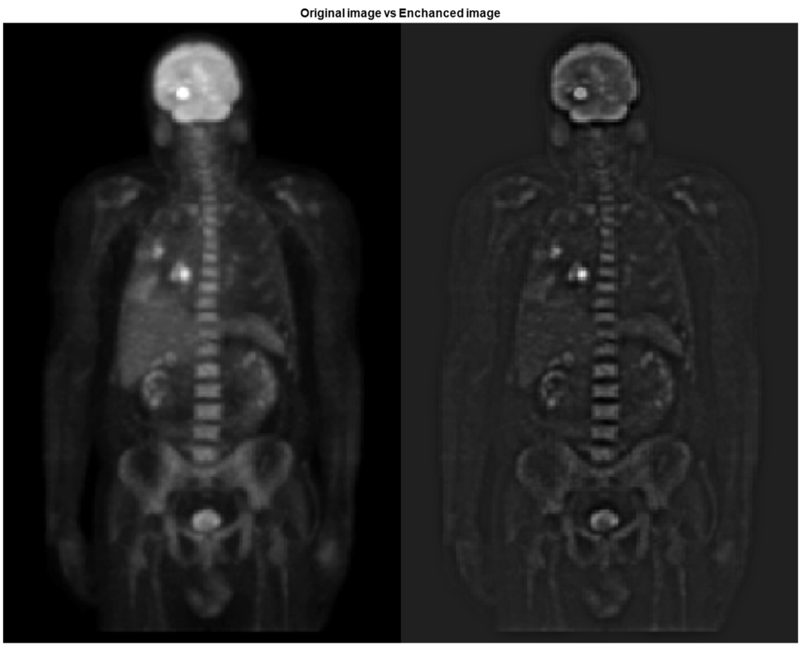

Figure 12

For sigma = 10 and const=5 we get result in Figure 13.

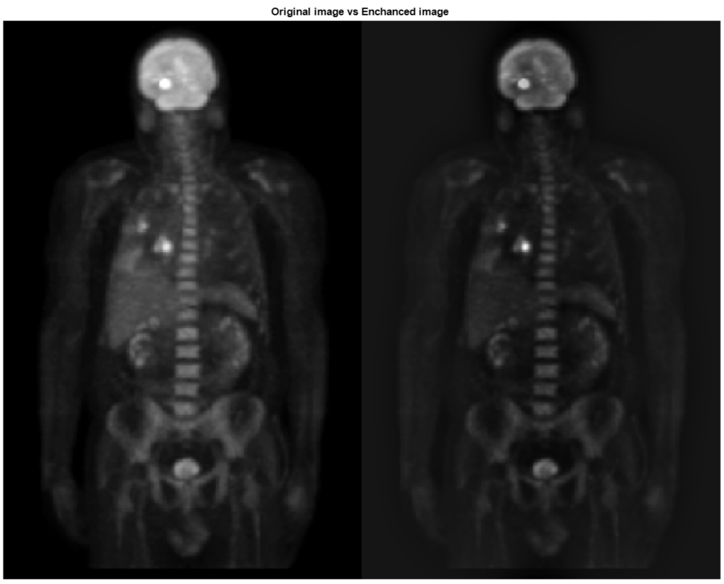

Figure 13

For sigma = 20 and const=10 we get result in Figure 14.

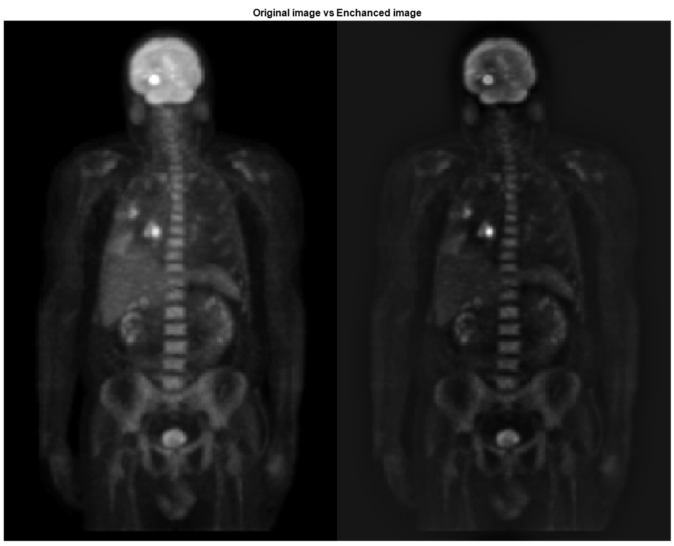

Figure 14

For sigma = 20 and const=5 we get result in Figure 15.

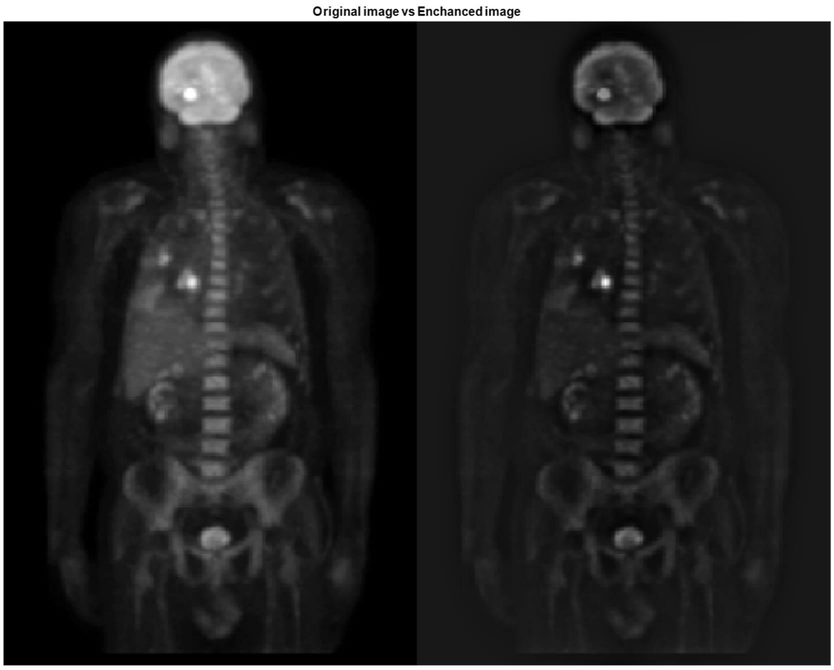

Figure 15

I would prefer the image with sigma=20 and const=1 (Figure 12) because its clearer and it has better view of body and organ segment (more detailed (resolution)).