```matlab
clear all
close all
clc



%% Visualization of ECG Signal
load ('100m.mat');
ecgsig = val/200;
t = 0:length(ecgsig)-1;
Fs = 360; % Sampling Frequency
tx = t./Fs;
subplot (5, 1, 1), plot(tx,ecgsig), title ('ECG Signal with artifacts'), grid on

%% Removal of Baseline wander using Biorthogonal Wavelet
[C, L] = wavedec (ecgsig,9,'bior3.7'); % Decomposition
a9 = wrcoef ('a', C, L,'bior3.7',9); % Approximate Component
d9 = wrcoef ('d', C, L,'bior3.7',9); % Detailed components
d8 = wrcoef ('d', C, L,'bior3.7',8);
d7 = wrcoef ('d', C, L,'bior3.7',7);
d6 = wrcoef ('d', C, L,'bior3.7',6);
d5 = wrcoef ('d', C, L,'bior3.7',5);
d4 = wrcoef ('d', C, L,'bior3.7',4);
d3 = wrcoef ('d', C, L,'bior3.7',3);
d2 = wrcoef ('d', C, L,'bior3.7',2);
d1 = wrcoef ('d', C, L,'bior3.7',1);
y0= d9+d8+d7+d6+d5+d4+d3+d2+d1;
subplot (4,1,2), plot(tx,y0), title ('ECG Signal after baseline wander removed'),↲
grid on


%% Removal of Powerline Interference using Notch Filter
Fnotch = 50; % Notch Frequency
BW = 100; % Bandwidth
Apass = 1; % Bandwidth Attenuation
[b, a] = iirnotch (Fnotch/ (Fs/2), BW/ (Fs/2), Apass);
Hd1 = dfilt.df2 (b, a);
y1=filter (Hd1, y0);
subplot (5, 1, 4), plot (tx,y1), title ('ECG signal with powerline interference↲
removed'), grid on

%% Removal of EMG noise using Biorthogonal wavelet
[C, L] = wavedec (y1,2,'bior3.7'); % Decomposition
a2 = wrcoef ('a', C, L,'bior3.7',2); % Approximate Component
d2 = wrcoef ('d', C, L,'bior3.7',2); % Detailed components
d1 = wrcoef ('d', C, L,'bior3.7',1);
y2 = a2 + d2;
subplot(5,1,5)
plot(tx,y2),title('ECG Signal with high frequency noise removed'), grid on
```

```matlab
%% Denoising of ECG Signal using Daubechies wavelet
[C, L] = wavedec (y2,4,'db4'); % Decomposition
a4 = wrcoef ('a', C, L,'db4',4); % Approximate Component
d4 = wrcoef ('d', C, L,'db4',4); % Detailed components
d3 = wrcoef ('d', C, L,'db4',3);
d2 = wrcoef ('d', C, L,'db4',2);
d1 = wrcoef ('d', C, L,'db4',1);
y3 = a4 + d4 + d3;

%% PQRST Detection
[Rpeaks,locs_r] = findpeaks(y3,t,'MinPeakHeight',0.4,'MinPeakDist',50);
nohb_r = length(locs_r);
for i = 1:nohb_r
    Speaks(i) = min(y3(locs_r(i):locs_r(i)+15));
    locs_s(i) = find(y3==Speaks(i))-1;
end


for i = 1:nohb_r
    Qpeaks(i) = min(y3(locs_r(i)-15:locs_r(i)));
    locs_q(i) = find(y3==Qpeaks(i));
end

for i = 1:nohb_r
     if locs_q(i) - 60 > 0
        Ppeaks(i) = max(y3(locs_q(i)-60:locs_q(i)));
        locs_p(i) = find(y3==Ppeaks(i));
    else
        Ppeaks(i) = max(y3(locs_q(i)-10:locs_q(i)));
        locs_p(i) = find(y3==Ppeaks(i));
    end
end

for i = 1:nohb_r
    if locs_s(i) + 130 <= 3600
        Tpeaks(i) = max(y3(locs_s(i):locs_s(i)+130));
        locs_t(i) = find(y3==Tpeaks(i));
    else
        break
    end
end




timelimit = length(ecgsig)/Fs;
hbpermin = (nohb_r*60)/timelimit;
disp(strcat('Heart Rate = ',num2str(hbpermin)))

figure
```

```matlab
plot(t,y3)
grid on
xlim([0,length(ecgsig)])
hold on

plot(locs_r,Rpeaks,'^r');
plot(locs_s,Speaks,'xm')
plot(locs_q,Qpeaks,'*g')
plot(locs_p,Ppeaks,'om')
plot(locs_t,Tpeaks,'pk')

xlabel('samples')
legend('','Rpeaks','Speaks','Qpeaks','Ppeaks','Tpeaks')
title(strcat('PQRST Detection and Heart Rate : ',num2str(hbpermin)))
```