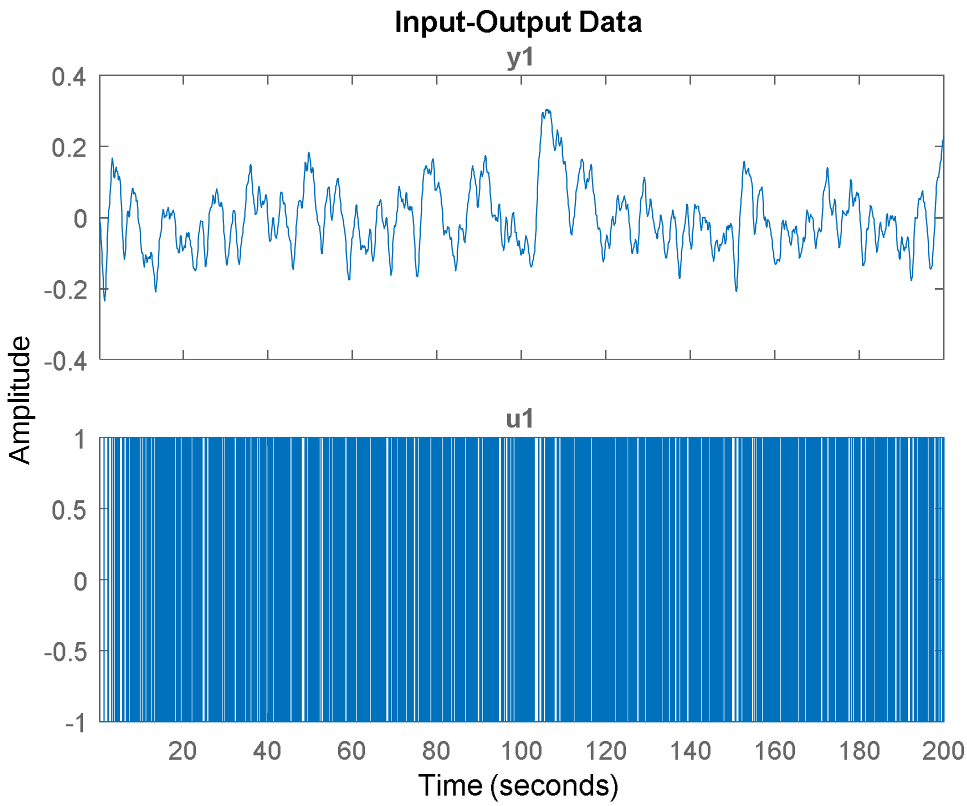
Question 1 –

a)

Here is the code for this part.

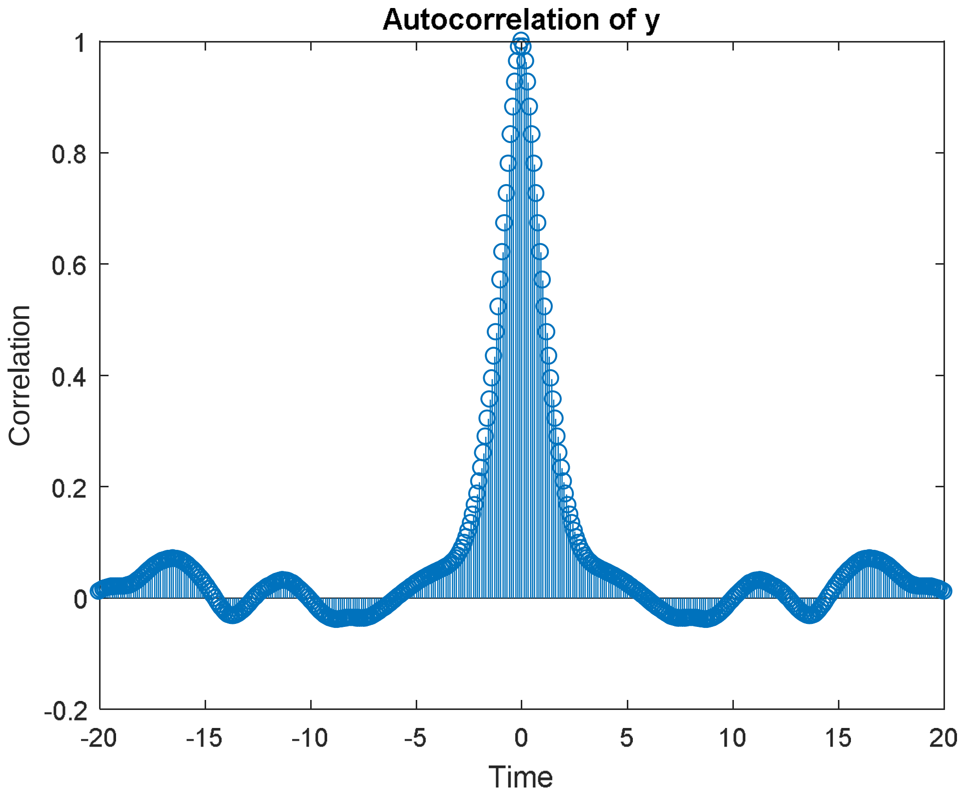
```
num=1;
den=[1 3 2];
sys = tf(num,den);
Fs = 10;                % Sampling frequency
Ts = 1/Fs;              % Sample time
t = 0:Ts:200;
N = length(t);
u = idinput(N,'PRBS');
y = lsim(sys,u,t);
data = iddata(y,u,Ts);
figure;
plot(data);
```



b)

Autocorrelation can be plotted using xcorr. Since xcorr considers time lag between samples, we should use 200 here in this function. Here is the code for this part.

```
%% Correlation analysis
tau = -20:Ts:20;
r = xcorr(y,200,'coeff');
figure;
stem(tau, r);
title('Autocorrelation of y');
xlabel('Time');
ylabel('Correlation');
```

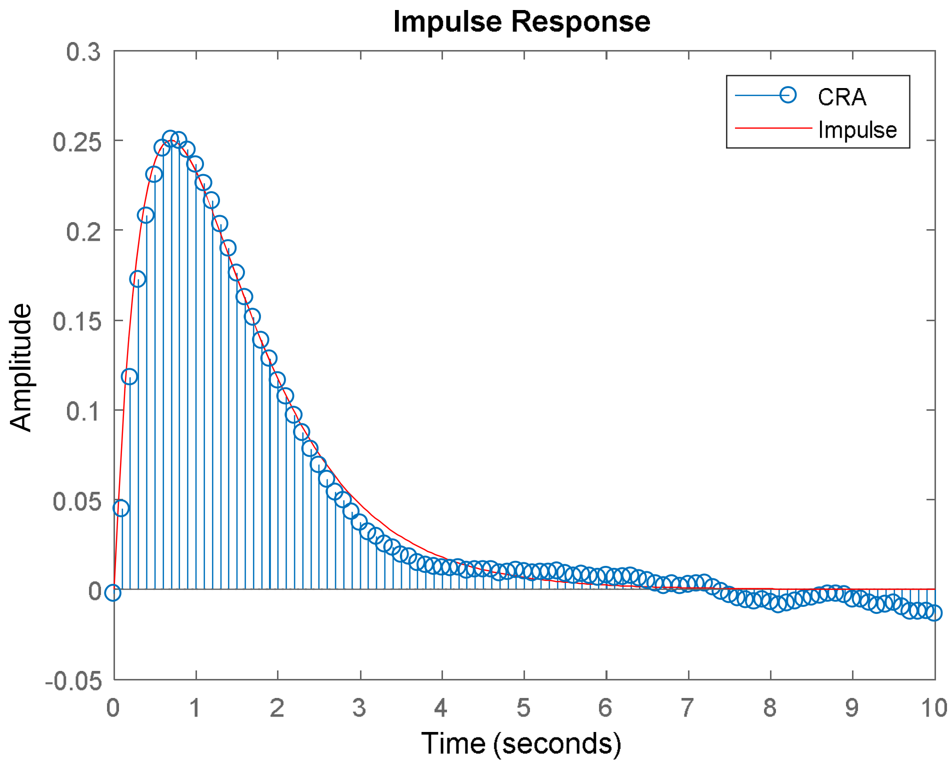


c)

We use cra and impulse command for estimating impulse response. Here is the MATLAB code for this part.

```
%% Impulse response
figure
finalTime = 10;
tImp = 0:Ts:finalTime;
[IR,~,~] = cra(data, finalTime*Fs);
```

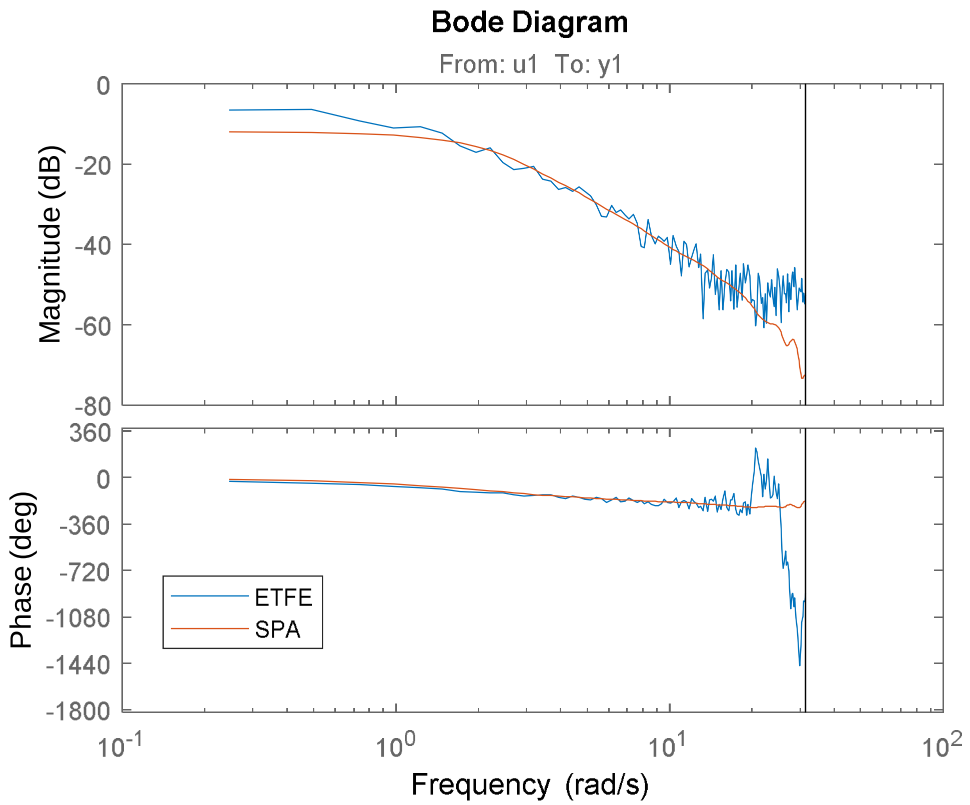
```
stem(tImp,IR*Fs);
hold on;
impulse(sys,finalTime);
hold off;
legend('CRA','Impulse');
```



d)

Here is the MATLAB code for this part.

```
%% Spectral analysis
RETFE = etfe(data);
RSPA = spa(data);
figure;
bode(RETFE,RSPA);
```


Bode Diagram
From: u1 To: y1
Magnitude (dB)
0
-20
-40
-60
-80
Phase (deg)
360
0
-360
-720
-1080
-1440
-1800
ETFE
SPA
10^{-1}
10^{0}
10^{1}
10^{2}
Frequency (rad/s)

.

Question 2 –

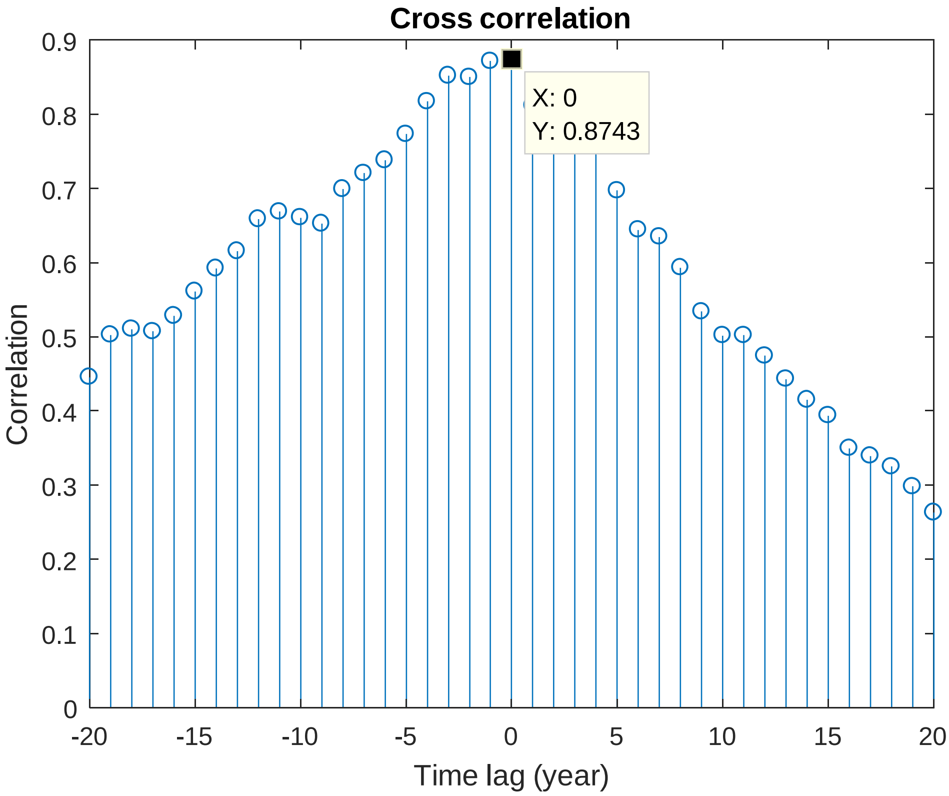
a)

The following MATLAB code is used for the analysis of this part.

```
clc
clear all;
close all;

% part a
data = [1980   1981  1982  1983  1984  1985  1986  1987  1988  1989  1990
   1991  1992  1993  1994  1995  1996  1997  1998  1999  2000  2001  2002
   2003  2004  2005  2006  2007  2008  2009  2010  2011  2012  2013  2014;
    6.463001268      3.833797117 7.341931344 9.245216354 13.63833419
   11.9091084  7.331332019 9.912166139 9.457901151 2.600704109 2.393612459
   7.81295779  12.82494547 12.56602799 11.78156869 9.750279002 8.782184882
   8.118548119 6.80780632  6.739270027 7.640001656 7.555801672 8.401915061
   9.352364261 9.45917505  10.74255231 12.09183627 13.63634486 9.093872102
   8.857029819 10.10310072 9.012854035 7.332030984 7.226936454
   6.755778416;
    4.305147809      3.578050295 1.101034617 4.83543596  1.471102565
   2.90843419  2.480293491 1.723703014 7.302963549 3.736988483 3.366900569
   -0.982546363      3.390699613 2.706142818 4.604720942 5.527286718
   5.526796934 2.118629228 4.243707664 6.892479991 2.015558933 3.021236285
   2.05811615  6.086693622 6.187574525 7.56712016  7.584629578 8.15356726
   2.375249298 6.950038738 8.763184414 5.248536528 4.134717786 5.096691727
   6.234203582];

data=data';
save data2.mat data -v7.3;
clear data
load data2.mat
```

b)

We use cross correlation analysis to analyse the correlation of these two dynamic variables. The result of correlation analysis is shown in figure below. The maximum of correlation happens in lag 0. This means that these two variables are correlated without any year delay. Since the correlation value at 0 year time lag is approximately 0.87 (it is OK if the results have some deviation), these variables can be considered as moderately correlated.



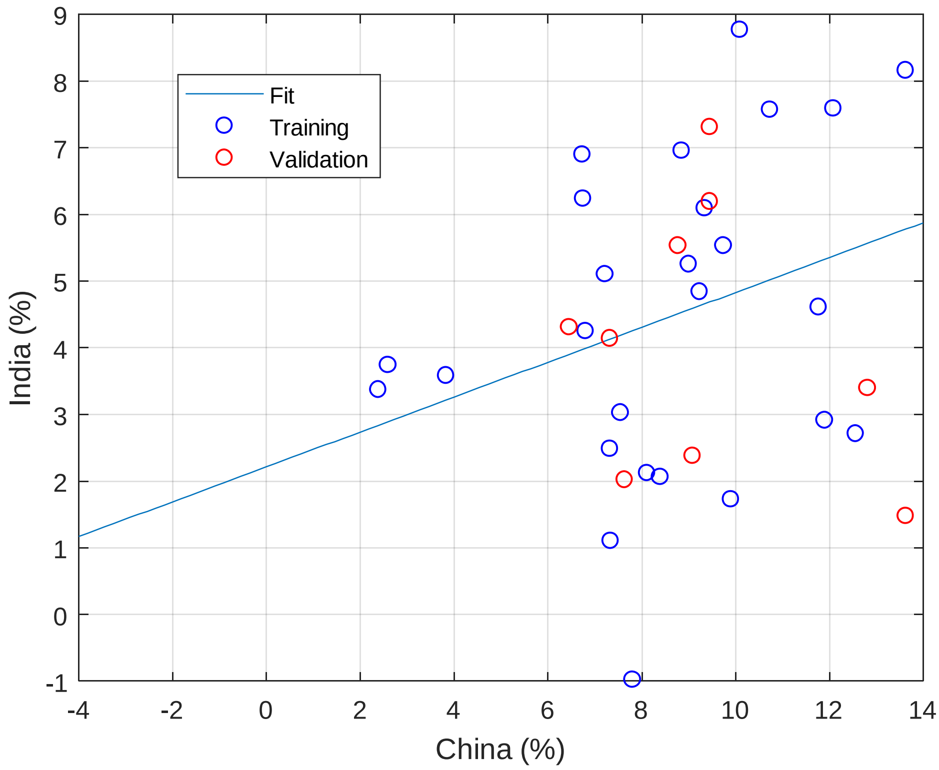
The following MATLAB code is used for the analysis of this part.

```
load data2.mat

year = data(:,1);
China = data(:,2);
India = data(:,3);

tau = -20:20;
r = xcorr(China, India, 20, 'coeff');
figure(1);
stem(tau, r);
title('Cross correlation');
xlabel('Time lag (year)');
ylabel('Correlation');
```

c)

In this part, we assume Chinese GDP growth and Indian GDP growth as the input and output of our regression problem, respectively. Data has been divided into two sets, training and validation sets. We used approximately 75% of the data for training and 25% for validation.

The fitted function and datasets are shown in figure below. The calculated value for the economic growth in the year 2015 with my fitted function is 3.88% (Here, it is OK to choose not to separate the data or validate, and the final results allows to have a certain deviation).



Here is the MATLAB code for this part.

```
idx_v = 1:4:length(China);
k = 0;

for i = 1:length(China)
    tempIdx = find(idx_v == i);
    if isempty(tempIdx)
        k = k+1;
        idx_t(k) = i;
    end
end

China_t = China(idx_t);
China_v = China(idx_v);
India_t = India(idx_t);
India_v = India(idx_v);

SSE_valid = [];
```

```
P1 = polyfit(China_t,India_t,1);


xx = linspace(-4,14,100);
yy = P1(1)*xx+P1(2);
figure(2);
plot(xx,yy);
hold on
scatter(China_t, India_t, 'b');
scatter(China_v, India_v, 'r');
grid on;
legend('Fit','Training','Validation');
xlabel('China (%)');
ylabel('India (%)');

x = 6.358383363;
India2015 = P1(1)*x+P1(2)
```