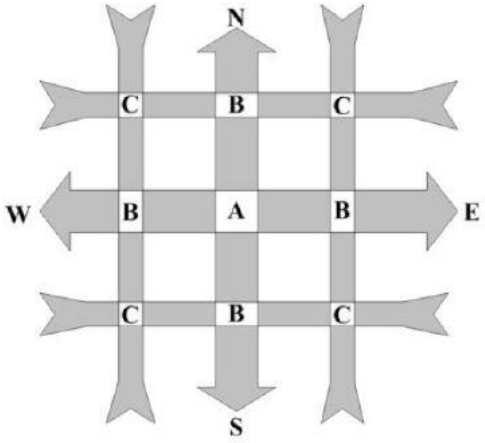
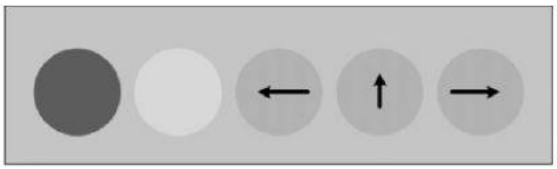


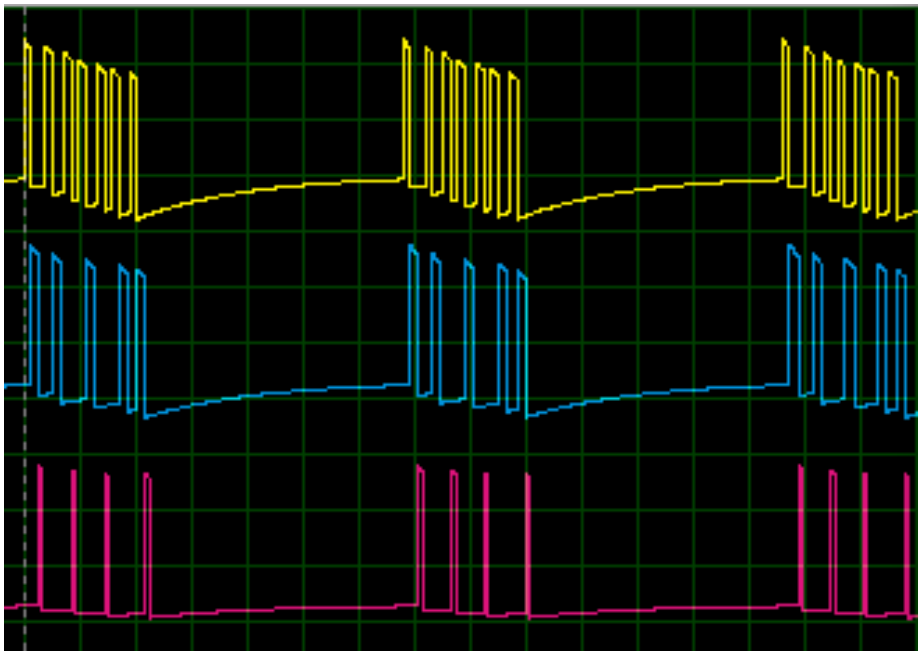


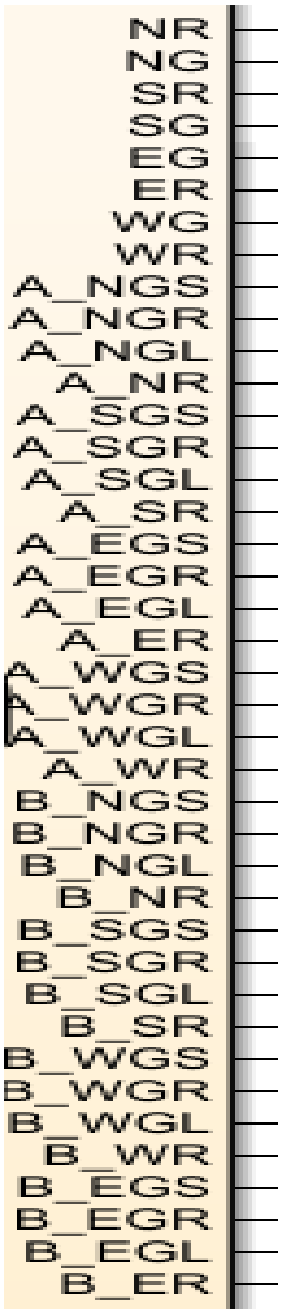
(a)

(b)

overview

Design of Traffic Light Control Systems Task Scheduling





controller combination

Priority wise A,B,C

Yellow pulse represents Controller A sub-task Scheduling

Blue pulse represents Controller B sub-task Scheduling

Pink pulse represents Controller C sub-task Scheduling

Notation for variables

"Controller_" "bound direction" "light" "move allow"

Controllers-A,B,C

Bound directions-North,South,West,East

Light-Green(with directions),Yellow, Red

Move allow-Left(L),right(R),straight(S)

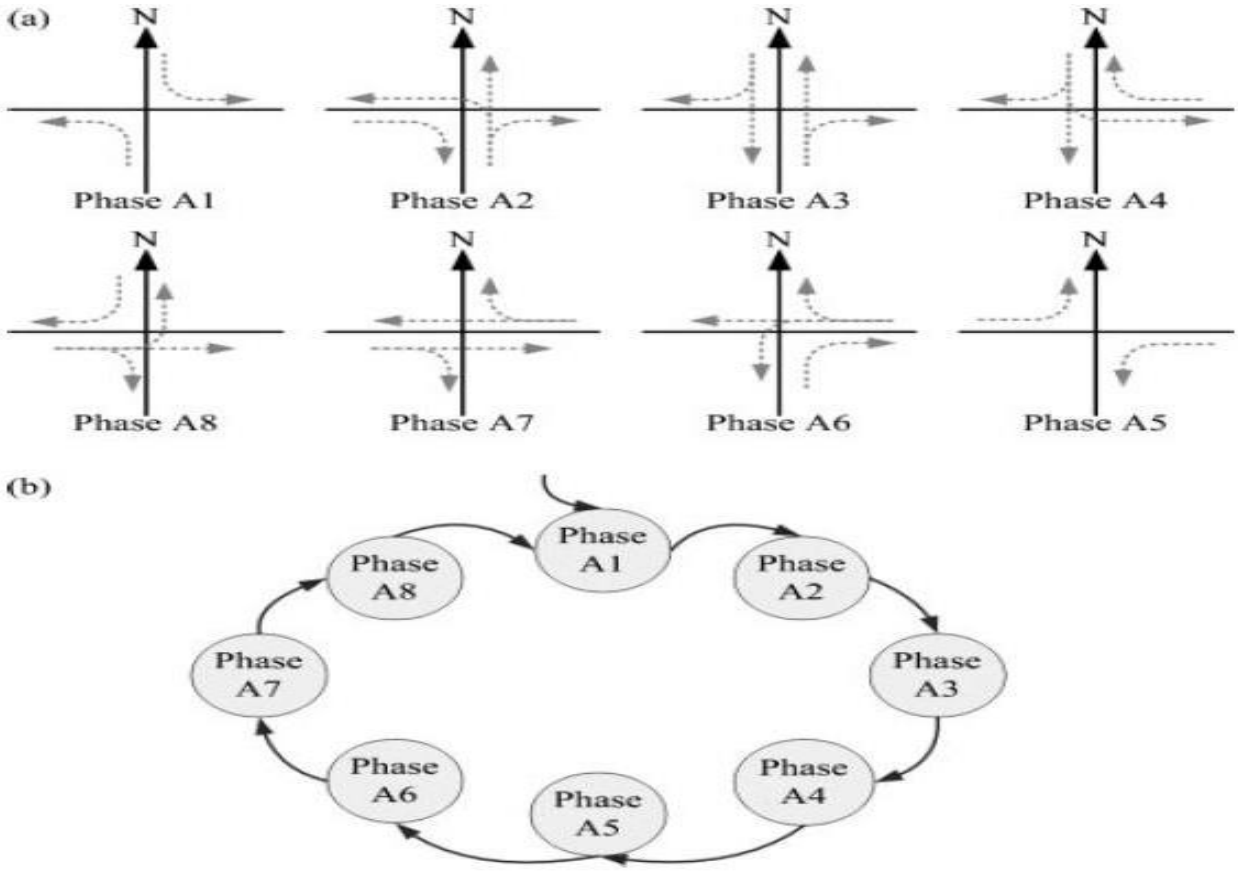
Assumptions:

- **Controller A last 8th phase not consider**
- **Controller B last 6th phase not consider**
- **Timings of Controller A 45msec (FROM A1 TO A2, FROM A2 TO A3 so on upto A7)**
- **Timings of Controller B 45msec (FROM B1 TO B2, FROM B2 TO B3 so on upto B5)**
- **Timings of Controller C 45msec (FROM C1 TO C2, FROM C2 TO C1)**
- **Simulation Graph shows the scheduling synchronisation(generated using I/O peripheral as per triggering of controller(A/B/C) sub task)**
- **Timing shown in simulation include peripheral execution time also (duration addition in actual switching between tasks ms wise)**

Priority	TIME	45ms	45ms	45ms	45ms	45ms	45ms	45ms
1	CONTROLLER *A*	A1	A2	A3	A4	A5	A6	A7
2	CONTROLLER B	B1	B2		B3		B4	B5
3	CONTROLLER C	C1		C2		C1		C2

For A

Traffic light indication by analysing bounds



Controller A

Variables used

- **A_NGS-**CONTROLLER-A NORTH BOUND GREEN SRAIGHT

(A_"**S/E/W**…BOUND" "G/Y…LIGHT" "**S/L/R**..DIRCTIONS")

- FOR RED LIGHT

A_NR-CONTROLLER-A NORTH BOUND RED

(A_"S/W/E"R)

45 msec transitions between states **A1-A2……A7**

For B

Variables used

- **B_NGS**-CONTROLLER-B NORTH BOUND GREEN SRAIGHT

(B_"**S/E/W**…BOUND" "G/Y…LIGHT" "**S/L/R**..DIRCTIONS")

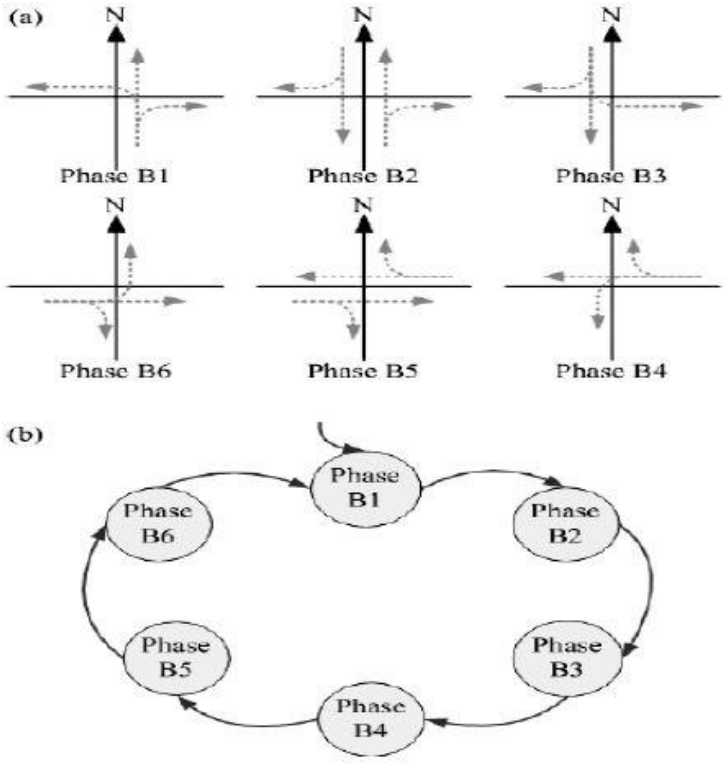
- FOR RED LIGHT

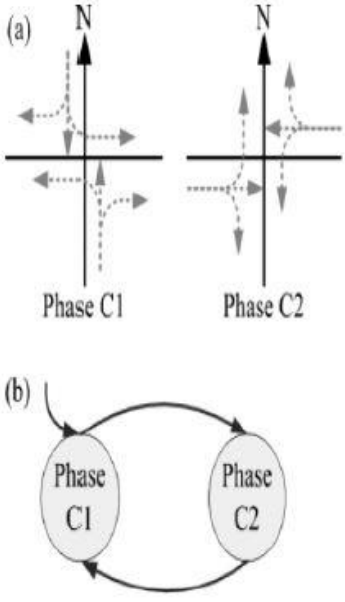
B_NR-CONTROLLER-B NORTH BOUND RED

(B_"S/W/E"R)

45 msec transitions between states **B1-B2,B4-B5**

90 msec transitions between states **for rest states**





For C

"BOUND DIRECTION" "LIGHT"

BOUND -N S E W,

LIGHT-G Y R

NG-NORTH BOUND GREEN

NR,SG,SR,EG,ER,WG,WR

90 sec transitions between states

----------ARDUINO CODE----------

```
#define A 2//i/o for controller A
#define B 3//i/o for controller B
#define C 4//i/o for controller C
void Aregion(void);
void Bregion(void);
void Cregion(void);

void A_1(void);
void A_2(void);
void A_3(void);
void A_4(void);
void A_5(void);
void A_6(void);
void A_7(void);
// void A_8(void);

void B_1(void);
void B_2(void);
void B_3(void);
void B_4(void);
void B_5(void);
// void B_6(void);
void C_1(void);
```

```
 void C_2(void);
 unsigned long  elapsedTime, Time=0, timePrev;

 void setup()
{

  Serial.begin(9600);
     pinMode(A, OUTPUT);   // Controller A directions of i/o
    pinMode(B, OUTPUT);  //Controller B
   pinMode(C, OUTPUT);//Controller C

}

void loop()
{

Serial.print("Controller START@");Serial.print(millis());//Serial.print("ms");Serial.println("   ");
//````````````````````````````````task1
Serial.print("t1 start@");Serial.print(millis());//Serial.print("ms");Serial.println("   ");
A_1();B_1();C_1();
delay(45);
//Serial.print("t1 finished@");Serial.print(millis());Serial.println("   ");

//````````````````````````````````task2
Serial.print("t1 finished->t2 start@");Serial.print(millis());//Serial.print("ms");Serial.println("   ");
A_2();B_2();
delay(45);
//Serial.print("t2 finished@");Serial.print(millis());Serial.print("ms");Serial.println("   ");

//````````````````````````````````task3
Serial.print("t2 finished->t3 start@");Serial.print(millis());//Serial.print("ms");Serial.println("   ");
```

```
A_3();C_2();
delay(45);
//Serial.print("t3 finished@");Serial.print(millis());Serial.print("ms");Serial.println("   ");

//````````````````````````````````task4
Serial.print("t1 finished->t4 start@");Serial.print(millis());//Serial.print("ms");Serial.println("   ");
A_4();B_3();
delay(45);
//Serial.print("t4 finished@");Serial.print(millis());Serial.print("ms");Serial.println("   ");

//````````````````````````````````task5
Serial.print("t4 finished->t5 start@");Serial.print(millis());//Serial.print("ms");Serial.println("   ");
A_5();C_1();
delay(45);
//Serial.print("t1 finished->t5 finished@");Serial.print(millis());Serial.print("ms");Serial.println("
");

//````````````````````````````````task6
Serial.print("t5 finished->t6 start@");Serial.print(millis());//Serial.print("ms");Serial.println("   ");
A_6();B_4();
delay(45);
//Serial.print("t6 finished@");Serial.print(millis());Serial.print("ms");Serial.println("   ");

//````````````````````````````````task7
Serial.print("t6 finished->t7 start@");Serial.print(millis());//Serial.print("ms");Serial.println("   ");
A_7();B_5();C_2();
delay(45);
//Serial.print("t7 finished@");Serial.print(millis());Serial.print("ms");Serial.println("   ");

Serial.print("--Controller END@-----");Serial.print(millis());//Serial.print("ms");Serial.println("   ");
delay(4500);
```

```
/*
//t8
A_8();
delay(45000);
//t9
A_1();
delay(45000);
//t10
A_2();B_6();//C_1();
delay(45000);
//Aregion();
//Bregion();
//Cregion();
*/
}
//sub task od Controller A
void A_1(void){
digitalWrite(A,HIGH);
Serial.println(" A1\n\r NB A_NGS=0  A_NGL=1  A_NGR=0 A_NR=0");
Serial.println( "SB A_SGS=0 A_SGL=1 A_SGR=0 A_SR=0");
Serial.println( "EB A_EGS=0 A_EGL=0 A_EGR=0 A_ER=1");
Serial.println( " WB A_WGS=0 A_WGL=0 A_WGR=0 A_WR=1");
//delay( 45000);
digitalWrite(A,LOW);
 }


 void A_2(void){
  digitalWrite(A,HIGH);
Serial.println( " A2\n\rNB A_NGS=1 A_NGL=1 A_NGR=1 A_NR=0 ");
Serial.println( "SB A_SGS=0 A_SGL=0 A_SGR=0 A_SR=1 ");
```

```
Serial.println( "EB A_EGS=0 A_EGL=0 A_EGR=1 A_ER=0 ");
Serial.println( "WB A_WGS=0 A_WGL=0 A_WGR=0 A_WR=1");
//delay( 45000);
digitalWrite(A,LOW);
 }
 void A_3(void){
  digitalWrite(A,HIGH);
 Serial.println( " A3\n\r NB A_NGS=1 A_NGL=0 A_NGR=1 A_NR=0 ");
Serial.println( "SB A_SGS=1 A_SGL=0 A_SGR=1 A_SR=0 ");
 Serial.println( "EB A_EGS=0 A_EGL=0 A_EGR=0 A_ER=1 ");
 Serial.println( " WB A_WGS=0 A_WGL=0 A_WGR=0 A_WR=1");
 //delay( 45000);
 digitalWrite(A,LOW);
 }
 void A_4(void){
  digitalWrite(A,HIGH);
Serial.println( " A4\n\rNB A_NGS=0 A_NGL=0 A_NGR=0 A_NR=1 ");
 Serial.println( "SB A_SGS=1 A_SGL=1 A_SGR=1 A_SR=0 ");
 Serial.println( "EB A_EGS=0 A_EGL=0 A_EGR=0 A_ER=0");
 Serial.println( "WB A_WGS=0 A_WGL=0 A_WGR=0 A_WR=0");
 //delay( 45000);
digitalWrite(A,LOW);
 }
 void A_5(void){
  digitalWrite(A,HIGH);
 Serial.println( " A5\n\r NB A_NGS=0 A_NGL=0 A_NGR=0 A_NR=1");
Serial.println( "SB A_SGS=0 A_SGL=0 A_SGR=0 SR=1");
Serial.println( "EB A_EGS=0 A_EGL=1 A_EGR=0 A_ER=0");
Serial.println( "WB A_WGS=0 A_WGL=1 A_WGR=0 A_WR=0 ");
//delay( 45000);
 digitalWrite(A,LOW);
```

```
 }
void A_6(void){
  digitalWrite(A,HIGH);
 Serial.println( " A6\n\rNB A_NGS=0 A_NGL=0 A_NGR=1 A_NR=0");
Serial.println( "SB A_SGS=0 A_SGL=0 A_SGR=0 A_SR=1");
Serial.println( "EB A_EGS=0 A_EGL=0 A_EGR=0 A_ER=1 ");
Serial.println( "WB A_WGS=1 A_WGL=1 A_WGR=0 A_WR=0 ");
 //delay( 45000);
 digitalWrite(A,LOW);
 }
 void A_7(void){
  digitalWrite(A,HIGH);
Serial.println( " A7\n\rNB A_NGS=0 A_NGL=0 A_NGR=0 A_NR=1");
Serial.println( "SB A_SGS=0 A_SGL=0 A_SGR=0 A_SR=0 ");
Serial.println( " EB A_EGS=0 A_EGL=0 A_EGR=1 A_ER=0 ");
 Serial.println( "EB A_EGS=1 A_EGL=0 A_EGR=1 A_ER=0 ");
 //delay( 45000);
 digitalWrite(A,LOW);
 }
/* void A_8(void){
  digitalWrite(A,HIGH);
 Serial.println( " A8  \n\r\n\rNB A_NGS=0 A_NGL=0 A_NGR=0 A_NR=1 ");
Serial.println( "SB A_SGS=0 A_SGL=0 A_SGR=1 A_SR=0");
Serial.println( "EB A_EGS=1 A_EGL=1 A_EGR=1 A_ER=0");
Serial.println( "WB A_WGS=0 A_WGL=0 A_WGR=0 A_WR=0");
//delay( 45000);
 digitalWrite(A,LOW);
 }*/
//----------------------------
//sub task od Controller B
 void B_1(void){
```

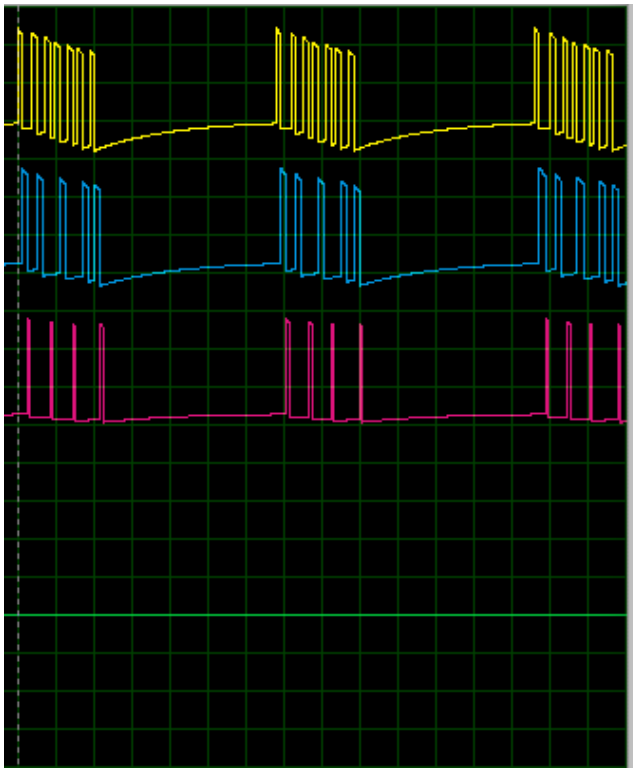
```
 digitalWrite(B,HIGH);
 Serial.println( " B1\n\rNB B_NGS=1 B_NGL=1 B_NGR=1 B_NR=0");
Serial.println( " SB B_SGS=0 B_SGL=0 B_SGR=0 B_SR=1");
 Serial.println( " EB B_EGS=0 B_EGL=0 B_EGR=0 B_ER=1 ");
 Serial.println( " WB B_WGS=0 B_WGL=0 B_WGR=0 B_WR=1 ");
 //delay( 45000);
digitalWrite(B,LOW);
 }
void B_2(void){
 digitalWrite(B,HIGH);
 Serial.println( " B2\n\r NB B_NGS=1 B_NGL=0 B_NGR=1 B_NR=0 ");
Serial.println( "SB B_SGS=1 B_SGL=0 B_SGR=1 B_SR=0");
Serial.println( "EB B_EGS=0 B_EGL=0 B_EGR=0 B_ER=1 ");
Serial.println( "WB B_WGS=0 B_WGL=0 B_WGR=0 B_WR=1");
//delay( 90000);
digitalWrite(B,LOW);
 }
 void B_3(void){
digitalWrite(B,HIGH);
Serial.println( " B3\n\r\n\rNB B_NGS=0 B_NGL=0 B_NGR=0 B_NR=1 ");
Serial.println( " SB B_SGS=1 B_SGL=1 B_SGR=1 B_SR=0 ");
Serial.println( "EB B_EGS=0 B_EGL=0 B_EGR=0 B_ER=1");
Serial.println( "WB B_WGS=0 B_WGL=0 B_WGR=0 B_WR=1 ");
//delay( 90000);
digitalWrite(B,LOW);
 }

 void B_4(void){
digitalWrite(B,HIGH);
Serial.println( " B4\n\rNB B_NGS=0 B_NGL=0 B_NGR=0 B_NR=1");
Serial.println( "SB B_SGS=0 B_SGL=0 B_SGR=0 B_SR=1");
```

```
Serial.println( " EB B_EGS=0 B_EGL=0 B_EGR=0 B_ER=1 ");
Serial.println( "WB B_WGS=1 B_WGL=1 B_WGR=1 B_WR=0");
digitalWrite(B,LOW);
 }
void B_5(void){
digitalWrite(B,HIGH);
Serial.println( " B5\n\r NB B_NGS=0 B_NGL=0B_NGR=0 B_NR=1 ");
Serial.println( "SB B_SGS=0 B_SGL=0 B_SGR=0 B_SR=1 ");
Serial.println( "EB B_EGS=1 B_EGL=0 B_EGR=1 B_ER=0");
Serial.println( "WB B_WGS=1 B_WGL=0 B_WGR=1 B_WR=0");
//delay( 90000);
digitalWrite(B,LOW);
 }
/*void B_6(void){
  digitalWrite(B,HIGH);
  Serial.println( " B6\n\rNB B_NGS=0 B_NGL=0 B_NGR=0 B_NR=1");
Serial.println( " SB B_SGS=0 B_SGL=0 B_SGR=0 B_SR=1");
Serial.println( " EB B_EGS=1 B_EGL=1 B_EGR=1 B_ER=0 ");
 Serial.println( " WB B_WGS=0 B_WGL=0 B_WGR=0 B_WR=1");
 ///delay( 45000);
digitalWrite(B,LOW);
 } */



//-----------------------------
//sub task od Controller C
void C_1(void){
digitalWrite(C,HIGH);
Serial.println( " C1\n\rNB NG=1 NR=0  ");
```

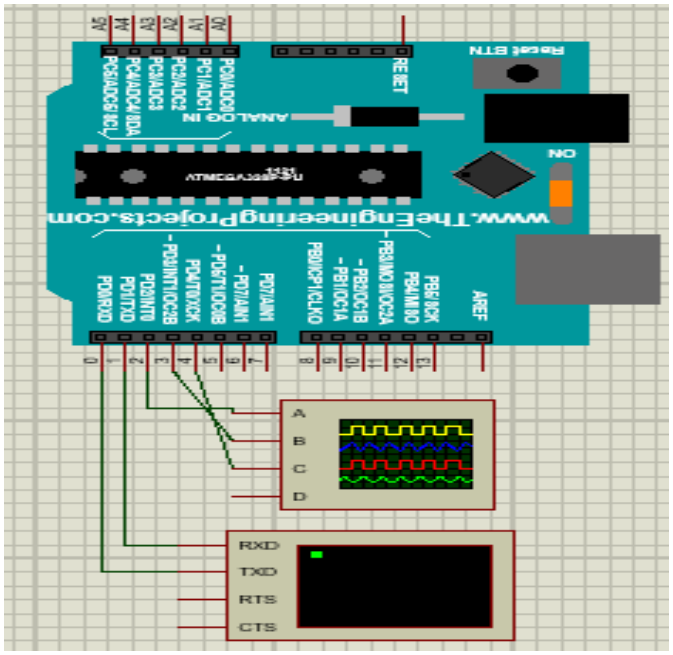
```
Serial.println( " SB SG=1 SR=0 ");

Serial.println( " EB EG=0 ER=1 ");

 Serial.println( "WB WG=0 WR=1");
 digitalWrite(C,LOW);
 //delay( 90000);
 //digitalWrite(C,HIGH);digitalWrite(C,LOW);
 }
 void C_2(void){
 digitalWrite(C,HIGH);
Serial.println( " C2\n\rNB NG=0 NR=1");

Serial.println( "SB SG=0 SR=1  ");

Serial.println( " EB EG=1 ER=0  ");

 Serial.println( "WB WG=1 WR=0 ");
 digitalWrite(C,LOW);
 //delay( 90000);
 //digitalWrite(C,HIGH);digitalWrite(C,LOW);
 }

//-----------------------------

void Aregion(void)
{
 A_1();
 delay( 45000);
  A_2();
 delay( 45000);
```

```
 A_3();
 delay( 45000);
  A_4();
 delay( 45000);
  A_5();
 delay( 45000);
  A_6();
  delay( 45000);
  A_7();
 delay( 45000);
//  A_8();
//delay( 45000);
}
void Bregion(void)
{
 B_1();delay( 45000);
 B_2();delay( 90000);
 B_3();delay( 90000);
 B_4();delay( 45000);
 B_5();delay( 90000);
// B_6();delay( 90000);
}
void Cregion(void)
{
 C_1();delay( 90000);
 C_2();delay( 90000);
}
```

Result:



```
Controller START@0t1 start@0 A1
 NB A_NGS=0  A_NGL=1  A_NGR=0 A_NR=0
SB A_SGS=0 A_SGL=1 A_SGR=0 A_SR=0
EB A_EGS=0 A_EGL=0 A_EGR=0 A_ER=1
 WB A_WGS=0 A_WGL=0 A_WGR=0 A_WR=1
 B1
NB B_NGS=1 B_NGL=1 B_NGR=1 B_NR=0
 SB B_SGS=0 B_SGL=0 B_SGR=0 B_SR=1
 EB B_EGS=0 B_EGL=0 B_EGR=0 B_ER=1
 WB B_WGS=0 B_WGL=0 B_WGR=0 B_WR=1
 C1
NB NG=1 NR=0
 SB SG=1 SR=0
 EB EG=0 ER=1
WB WG=0 WR=1
t1 finished->t2 start@387 A2
NB A_NGS=1 A_NGL=1 A_NGR=1 A_NR=0
SB A_SGS=0 A_SGL=0 A_SGR=0 A_SR=1
EB A_EGS=0 A_EGL=0 A_EGR=1 A_ER=0
WB A_WGS=0 A_WGL=0 A_WGR=0 A_WR=1
 B2
 NB B_NGS=1 B_NGL=0 B_NGR=1 B_NR=0
SB B_SGS=1 B_SGL=0 B_SGR=1 B_SR=0
EB B_EGS=0 B_EGL=0 B_EGR=0 B_ER=1
WB B_WGS=0 B_WGL=0 B_WGR=0 B_WR=1
t2 finished->t3 start@720 A3
 NB A_NGS=1 A_NGL=0 A_NGR=1 A_NR=0
SB A_SGS=1 A_SGL=0 A_SGR=1 A_SR=0
EB A_EGS=0 A_EGL=0 A_EGR=0 A_ER=1
 WB A_WGS=0 A_WGL=0 A_WGR=0 A_WR=1
 C2
NB NG=0 NR=1
SB SG=0 SR=1
```



SERIAL Print

NOTE: Timing in ms

Controller START@0t1 start@0 A1

NB A_NGS=0 A_NGL=1 A_NGR=0 A_NR=0

SB A_SGS=0 A_SGL=1 A_SGR=0 A_SR=0

EB A_EGS=0 A_EGL=0 A_EGR=0 A_ER=1

WB A_WGS=0 A_WGL=0 A_WGR=0 A_WR=1

B1

NB B_NGS=1 B_NGL=1 B_NGR=1 B_NR=0

SB B_SGS=0 B_SGL=0 B_SGR=0 B_SR=1

EB B_EGS=0 B_EGL=0 B_EGR=0 B_ER=1

WB B_WGS=0 B_WGL=0 B_WGR=0 B_WR=1

C1

NB NG=1 NR=0

SB SG=1 SR=0

EB EG=0 ER=1

WB WG=0 WR=1

t1 finished->t2 start@387 A2

NB A_NGS=1 A_NGL=1 A_NGR=1 A_NR=0

SB A_SGS=0 A_SGL=0 A_SGR=0 A_SR=1

EB A_EGS=0 A_EGL=0 A_EGR=1 A_ER=0

WB A_WGS=0 A_WGL=0 A_WGR=0 A_WR=1

B2

NB B_NGS=1 B_NGL=0 B_NGR=1 B_NR=0

SB B_SGS=1 B_SGL=0 B_SGR=1 B_SR=0

EB B_EGS=0 B_EGL=0 B_EGR=0 B_ER=1

WB B_WGS=0 B_WGL=0 B_WGR=0 B_WR=1

t2 finished->t3 start@720 A3

NB A_NGS=1 A_NGL=0 A_NGR=1 A_NR=0

SB A_SGS=1 A_SGL=0 A_SGR=1 A_SR=0

EB A_EGS=0 A_EGL=0 A_EGR=0 A_ER=1

WB A_WGS=0 A_WGL=0 A_WGR=0 A_WR=1

C2

NB NG=0 NR=1

SB SG=0 SR=1

EB EG=1 ER=0

WB WG=1 WR=0

t1 finished->t4 start@972 A4

NB A_NGS=0 A_NGL=0 A_NGR=0 A_NR=1

SB A_SGS=1 A_SGL=1 A_SGR=1 A_SR=0

EB A_EGS=0 A_EGL=0 A_EGR=0 A_ER=0

WB A_WGS=0 A_WGL=0 A_WGR=0 A_WR=0

B3

NB B_NGS=0 B_NGL=0 B_NGR=0 B_NR=1

SB B_SGS=1 B_SGL=1 B_SGR=1 B_SR=0

EB B_EGS=0 B_EGL=0 B_EGR=0 B_ER=1

WB B_WGS=0 B_WGL=0 B_WGR=0 B_WR=1

t4 finished->t5 start@1308 A5

NB A_NGS=0 A_NGL=0 A_NGR=0 A_NR=1

SB A_SGS=0 A_SGL=0 A_SGR=0 SR=1

EB A_EGS=0 A_EGL=1 A_EGR=0 A_ER=0

WB A_WGS=0 A_WGL=1 A_WGR=0 A_WR=0

C1

NB NG=1 NR=0

SB SG=1 SR=0

EB EG=0 ER=1

WB WG=0 WR=1

t5 finished->t6 start@1556 A6

NB A_NGS=0 A_NGL=0 A_NGR=1 A_NR=0

SB A_SGS=0 A_SGL=0 A_SGR=0 A_SR=1

EB A_EGS=0 A_EGL=0 A_EGR=0 A_ER=1

WB A_WGS=1 A_WGL=1 A_WGR=0 A_WR=0

B4

NB B_NGS=0 B_NGL=0 B_NGR=0 B_NR=1

SB B_SGS=0 B_SGL=0 B_SGR=0 B_SR=1

EB B_EGS=0 B_EGL=0 B_EGR=0 B_ER=1

WB B_WGS=1 B_WGL=1 B_WGR=1 B_WR=0

t6 finished->t7 start@1888 A7

NB A_NGS=0 A_NGL=0 A_NGR=0 A_NR=1

SB A_SGS=0 A_SGL=0 A_SGR=0 A_SR=0

EB A_EGS=0 A_EGL=0 A_EGR=1 A_ER=0

EB A_EGS=1 A_EGL=0 A_EGR=1 A_ER=0

B5

NB B_NGS=0 B_NGL=0B_NGR=0 B_NR=1

SB B_SGS=0 B_SGL=0 B_SGR=0 B_SR=1

EB B_EGS=1 B_EGL=0 B_EGR=1 B_ER=0

WB B_WGS=1 B_WGL=0 B_WGR=1 B_WR=0

C2

NB NG=0 NR=1

SB SG=0 SR=1

EB EG=1 ER=0

WB WG=1 WR=0

--Controller END@-----2293Controller START@6793t1 start@6793 A1