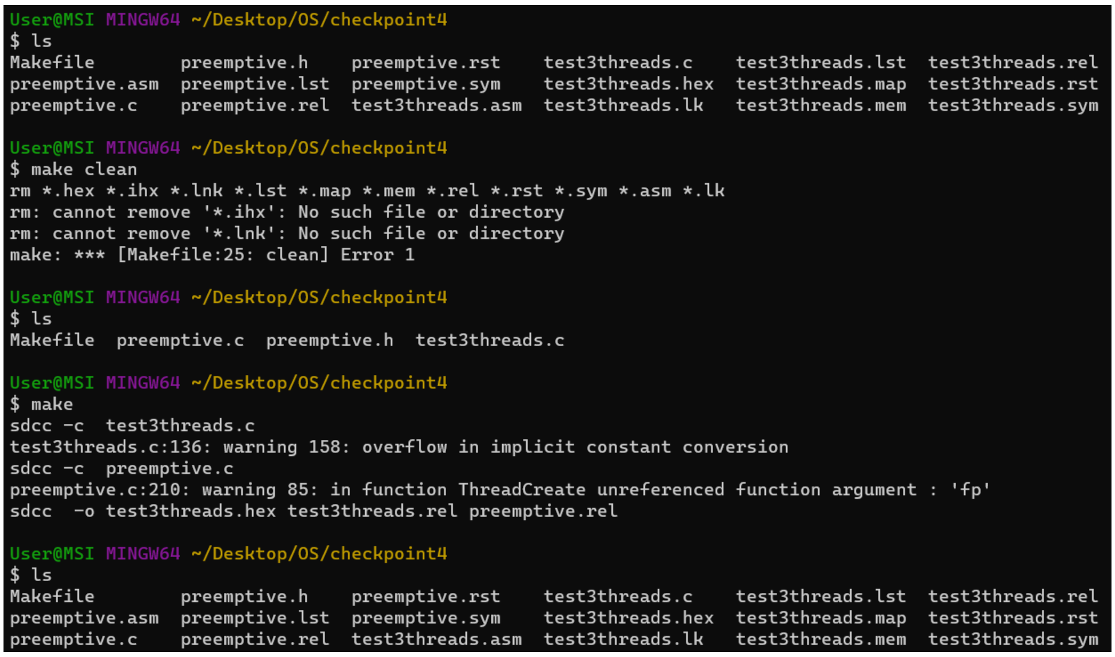
Name: 吳嘉濬 Student ID: 109021115

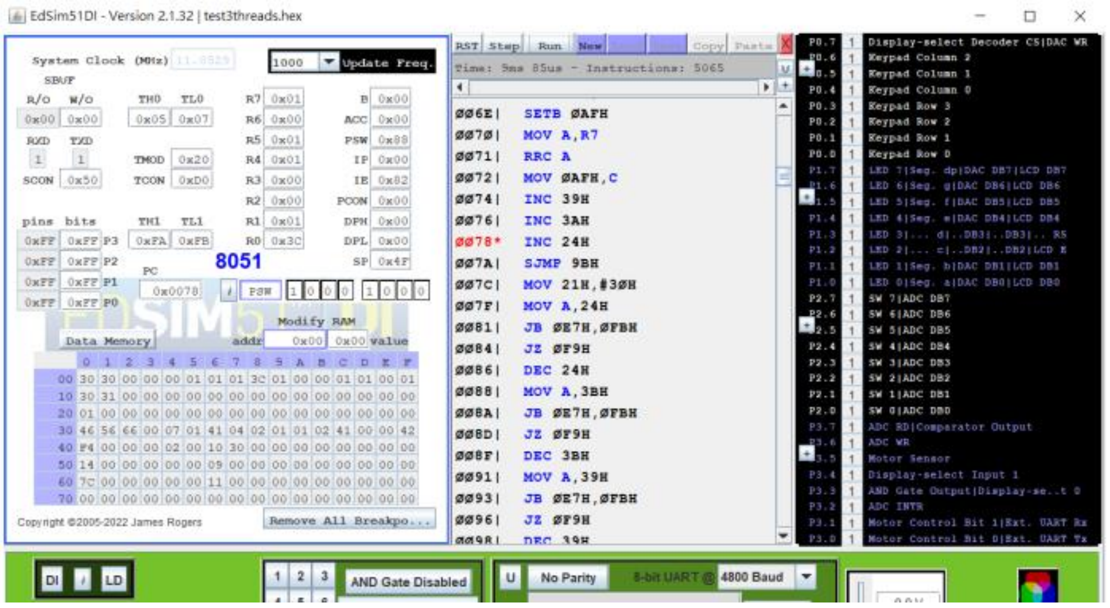

```
User@MSI MINGW64 ~/Desktop/OS/checkpoint4
$ ls
Makefile        preemptive.h    preemptive.rst    test3threads.c    test3threads.lst  test3threads.rel
preemptive.asm  preemptive.lst  preemptive.sym    test3threads.hex  test3threads.map  test3threads.rst
preemptive.c    preemptive.rel  test3threads.asm  test3threads.lk   test3threads.mem  test3threads.sym

User@MSI MINGW64 ~/Desktop/OS/checkpoint4
$ make clean
rm *.hex *.ihx *.lnk *.lst *.map *.mem *.rel *.rst *.sym *.asm *.lk
rm: cannot remove '*.ihx': No such file or directory
rm: cannot remove '*.lnk': No such file or directory
make: *** [Makefile:25: clean] Error 1

User@MSI MINGW64 ~/Desktop/OS/checkpoint4
$ ls
Makefile  preemptive.c  preemptive.h  test3threads.c

User@MSI MINGW64 ~/Desktop/OS/checkpoint4
$ make
sdcc -c  test3threads.c
test3threads.c:136: warning 158: overflow in implicit constant conversion
sdcc -c  preemptive.c
preemptive.c:210: warning 85: in function ThreadCreate unreferenced function argument : 'fp'
sdcc  -o test3threads.hex test3threads.rel preemptive.rel

User@MSI MINGW64 ~/Desktop/OS/checkpoint4
$ ls
Makefile        preemptive.h    preemptive.rst    test3threads.c    test3threads.lst  test3threads.rel
preemptive.asm  preemptive.lst  preemptive.sym    test3threads.hex  test3threads.map  test3threads.rst
preemptive.c    preemptive.rel  test3threads.asm  test3threads.lk   test3threads.mem  test3threads.sym
```


EdSim51DI - Version 2.1.32 | test3threads.hex

```
System Clock (MHz) 11.0529        1000  Update Freq.
SBUF
R/O   W/O     TH0   TL0     R7 0x01      B 0x00
0x00  0x00    0x05  0x07    R6 0x00    ACC 0x00
RXD   TXD                   R5 0x01    PSW 0x88
1     1       TMOD 0x20     R4 0x01     IP 0x00
SCON 0x50     TCON 0xD0     R3 0x00     IE 0x82
                            R2 0x00   PCON 0x00
pins  bits    TH1   TL1     R1 0x01    DPH 0x00
0xFF  0xFF P3 0xFA  0xFB    R0 0x3C    DPL 0x00
0xFF  0xFF P2             8051          SP 0x4F
0xFF  0xFF P1   PC
0xFF  0xFF P0   0x0078     PSW 1 0 0 0  1 0 0 0
                           Modify RAM
Data Memory           addr 0x00  0x00 value

    0  1  2  3  4  5  6  7  8  9  A  B  C  D  E  F
00 30 30 00 00 00 01 01 01 3C 01 00 00 01 01 00 01
10 30 31 00 00 00 00 00 00 00 00 00 00 00 00 00 00
20 01 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
30 46 56 66 00 07 01 41 04 02 01 01 02 41 00 00 42
40 F4 00 00 00 02 00 10 30 00 00 00 00 00 00 00 00
50 14 00 00 00 00 00 09 00 00 00 00 00 00 00 00 00
60 7C 00 00 00 00 00 11 00 00 00 00 00 00 00 00 00
70 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00

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```
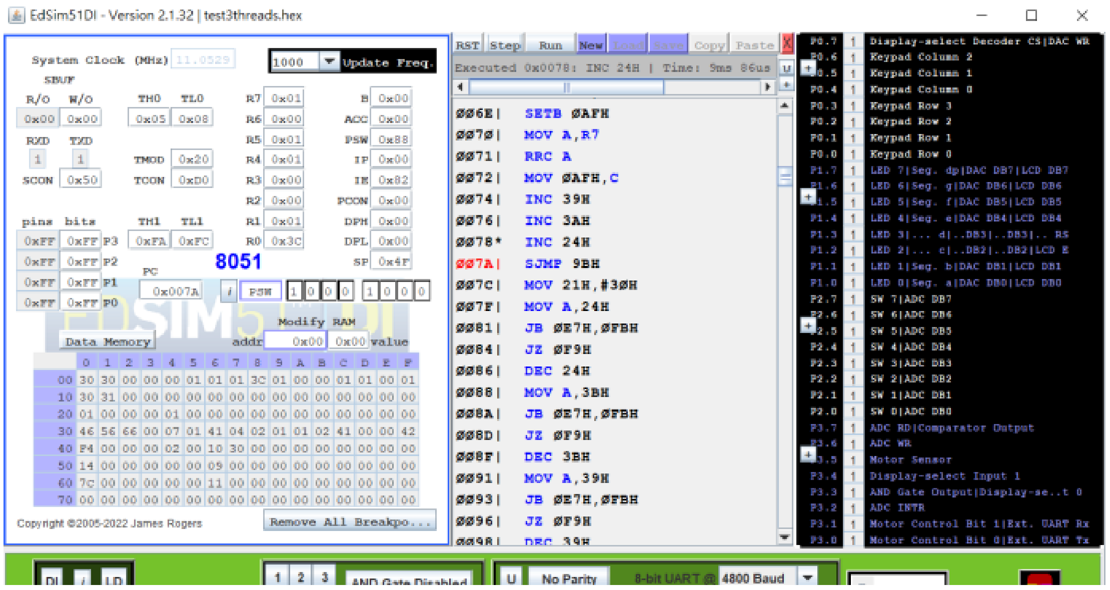

```
RST  Step  Run  New  Copy  Paste
Time: 9ms 85us - Instructions: 5065

ØØ6E|   SETB ØAFH
ØØ7Ø|   MOV A,R7
ØØ71|   RRC A
ØØ72|   MOV ØAFH,C
ØØ74|   INC 39H
ØØ76|   INC 3AH
ØØ78*   INC 24H
ØØ7A|   SJMP 9BH
ØØ7C|   MOV 21H,#3ØH
ØØ7F|   MOV A,24H
ØØ81|   JB ØE7H,ØFBH
ØØ84|   JZ ØF9H
ØØ86|   DEC 24H
ØØ88|   MOV A,3BH
ØØ8A|   JB ØE7H,ØFBH
ØØ8D|   JZ ØF9H
ØØ8F|   DEC 3BH
ØØ91|   MOV A,39H
ØØ93|   JB ØE7H,ØFBH
ØØ96|   JZ ØF9H
ØØ98|   DEC 39H
```

```
P0.7 1 Display-select Decoder CS|DAC WR
P0.6 1 Keypad Column 2
P0.5 1 Keypad Column 1
P0.4 1 Keypad Column 0
P0.3 1 Keypad Row 3
P0.2 1 Keypad Row 2
P0.1 1 Keypad Row 1
P0.0 1 Keypad Row 0
P1.7 1 LED 7|Seg. dp|DAC DB7|LCD DB7
P1.6 1 LED 6|Seg. g|DAC DB6|LCD DB6
P1.5 1 LED 5|Seg. f|DAC DB5|LCD DB5
P1.4 1 LED 4|Seg. e|DAC DB4|LCD DB4
P1.3 1 LED 3|... d|..DB3|..DB3|.. RS
P1.2 1 LED 2|... c|..DB2|..DB2|LCD E
P1.1 1 LED 1|Seg. b|DAC DB1|LCD DB1
P1.0 1 LED 0|Seg. a|DAC DB0|LCD DB0
P2.7 1 SW 7|ADC DB7
P2.6 1 SW 6|ADC DB6
P2.5 1 SW 5|ADC DB5
P2.4 1 SW 4|ADC DB4
P2.3 1 SW 3|ADC DB3
P2.2 1 SW 2|ADC DB2
P2.1 1 SW 1|ADC DB1
P2.0 1 SW 0|ADC DB0
P3.7 1 ADC RD|Comparator Output
P3.6 1 ADC WR
P3.5 1 Motor Sensor
P3.4 1 Display-select Input 1
P3.3 1 AND Gate Output|Display-se..t 0
P3.2 1 ADC INTR
P3.1 1 Motor Control Bit 1|Ext. UART Rx
P3.0 1 Motor Control Bit 0|Ext. UART Tx
```


EdSim51DI - Version 2.1.32 | test3threads.hex

```
System Clock (MHz) 11.0529        1000  Update Freq.
SBUF
R/O   W/O     TH0   TL0     R7 0x01      B 0x00
0x00  0x00    0x05  0x08    R6 0x00    ACC 0x00
RXD   TXD                   R5 0x01    PSW 0x88
1     1       TMOD 0x20     R4 0x01     IP 0x00
SCON 0x50     TCON 0xD0     R3 0x00     IE 0x82
                            R2 0x00   PCON 0x00
pins  bits    TH1   TL1     R1 0x01    DPH 0x00
0xFF  0xFF P3 0xFA  0xFC    R0 0x3C    DPL 0x00
0xFF  0xFF P2             8051          SP 0x4F
0xFF  0xFF P1   PC
0xFF  0xFF P0   0x007A     PSW 1 0 0 0  1 0 0 0
                           Modify RAM
Data Memory           addr 0x00  0x00 value

    0  1  2  3  4  5  6  7  8  9  A  B  C  D  E  F
00 30 30 00 00 00 01 01 01 3C 01 00 00 01 01 00 01
10 30 31 00 00 00 00 00 00 00 00 00 00 00 00 00 00
20 01 00 00 00 01 00 00 00 00 00 00 00 00 00 00 00
30 46 56 66 00 07 01 41 04 02 01 01 02 41 00 00 42
40 F4 00 00 00 02 00 10 30 00 00 00 00 00 00 00 00
50 14 00 00 00 00 00 09 00 00 00 00 00 00 00 00 00
60 7C 00 00 00 00 00 11 00 00 00 00 00 00 00 00 00
70 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00

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```
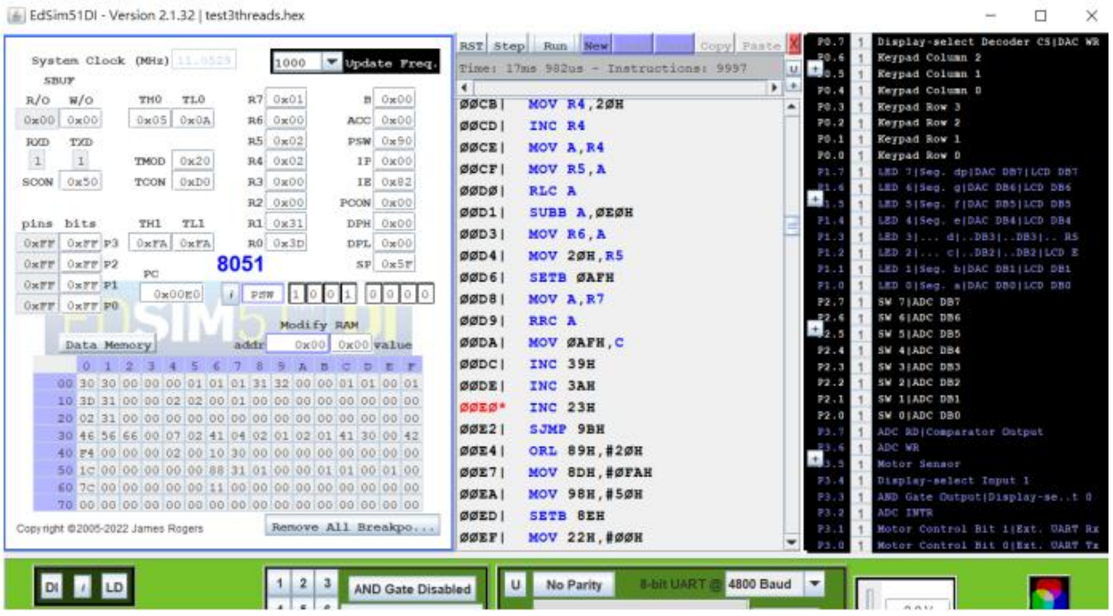

```
RST  Step  Run  New  Copy  Paste
Executed 0x0078: INC 24H | Time: 9ms 86us

ØØ6E|   SETB ØAFH
ØØ7Ø|   MOV A,R7
ØØ71|   RRC A
ØØ72|   MOV ØAFH,C
ØØ74|   INC 39H
ØØ76|   INC 3AH
ØØ78*   INC 24H
ØØ7A|   SJMP 9BH
ØØ7C|   MOV 21H,#3ØH
ØØ7F|   MOV A,24H
ØØ81|   JB ØE7H,ØFBH
ØØ84|   JZ ØF9H
ØØ86|   DEC 24H
ØØ88|   MOV A,3BH
ØØ8A|   JB ØE7H,ØFBH
ØØ8D|   JZ ØF9H
ØØ8F|   DEC 3BH
ØØ91|   MOV A,39H
ØØ93|   JB ØE7H,ØFBH
ØØ96|   JZ ØF9H
ØØ98|   DEC 39H
```

```
P0.7 1 Display-select Decoder CS|DAC WR
P0.6 1 Keypad Column 2
P0.5 1 Keypad Column 1
P0.4 1 Keypad Column 0
P0.3 1 Keypad Row 3
P0.2 1 Keypad Row 2
P0.1 1 Keypad Row 1
P0.0 1 Keypad Row 0
P1.7 1 LED 7|Seg. dp|DAC DB7|LCD DB7
P1.6 1 LED 6|Seg. g|DAC DB6|LCD DB6
P1.5 1 LED 5|Seg. f|DAC DB5|LCD DB5
P1.4 1 LED 4|Seg. e|DAC DB4|LCD DB4
P1.3 1 LED 3|... d|..DB3|..DB3|.. RS
P1.2 1 LED 2|... c|..DB2|..DB2|LCD E
P1.1 1 LED 1|Seg. b|DAC DB1|LCD DB1
P1.0 1 LED 0|Seg. a|DAC DB0|LCD DB0
P2.7 1 SW 7|ADC DB7
P2.6 1 SW 6|ADC DB6
P2.5 1 SW 5|ADC DB5
P2.4 1 SW 4|ADC DB4
P2.3 1 SW 3|ADC DB3
P2.2 1 SW 2|ADC DB2
P2.1 1 SW 1|ADC DB1
P2.0 1 SW 0|ADC DB0
P3.7 1 ADC RD|Comparator Output
P3.6 1 ADC WR
P3.5 1 Motor Sensor
P3.4 1 Display-select Input 1
P3.3 1 AND Gate Output|Display-se..t 0
P3.2 1 ADC INTR
P3.1 1 Motor Control Bit 1|Ext. UART Rx
P3.0 1 Motor Control Bit 0|Ext. UART Tx
```

Producer1 is running since the semaphore for preventing starvation “ok2” (at 0x24), (which is used to unlock Producer2) gets increased from 0 to 1.



```
EdSim51DI - Version 2.1.32 | test3threads.hex

System Clock (MHz) 11.0592        1000  Update Freq.
SBUF
R/O   W/O     TH0   TL0      R7 0x01       B 0x00
0x00  0x00    0x05  0x0A     R6 0x00     ACC 0x00
RXD   TXD                    R5 0x02     PSW 0x90
1     1       TMOD  0x20     R4 0x02      IP 0x00
SCON  0x50    TCON  0xD0     R3 0x00      IE 0x82
                             R2 0x00    PCON 0x00
pins  bits    TH1   TL1      R1 0x31     DPH 0x00
0xFF  0xFF P3 0xFA  0xFA     R0 0x3D     DPL 0x00
0xFF  0xFF P2             8051            SP 0x5F
0xFF  0xFF P1   PC
0xFF  0xFF P0   0x00E0       PSW 1 0 0 1  0 0 0 0
                             Modify RAM
Data Memory                  addr 0x00  0x00 value

    0  1  2  3  4  5  6  7  8  9  A  B  C  D  E  F
00 30 30 00 00 00 01 01 01 31 32 00 00 01 01 00 01
10 3D 31 00 00 02 02 00 01 00 00 00 00 00 00 00 00
20 02 31 00 00 00 00 00 00 00 00 00 00 00 00 00 00
30 46 56 66 00 07 02 41 04 02 01 02 01 41 30 00 42
40 F4 00 00 00 02 00 10 30 00 00 00 00 00 00 00 00
50 1C 00 00 00 00 00 88 31 01 00 00 01 01 00 01 00
60 7C 00 00 00 00 00 11 00 00 00 00 00 00 00 00 00
70 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00

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RST  Step  Run  New  Load  Save  Copy  Paste
Time: 17ms 982us - Instructions: 9997

ØØCB|   MOV R4,2ØH
ØØCD|   INC R4
ØØCE|   MOV A,R4
ØØCF|   MOV R5,A
ØØDØ|   RLC A
ØØD1|   SUBB A,ØEØH
ØØD3|   MOV R6,A
ØØD4|   MOV 2ØH,R5
ØØD6|   SETB ØAFH
ØØD8|   MOV A,R7
ØØD9|   RRC A
ØØDA|   MOV ØAFH,C
ØØDC|   INC 39H
ØØDE|   INC 3AH
ØØEØ*   INC 23H
ØØE2|   SJMP 9BH
ØØE4|   ORL 89H,#2ØH
ØØE7|   MOV 8DH,#ØFAH
ØØEA|   MOV 98H,#5ØH
ØØED|   SETB 8EH
ØØEF|   MOV 22H,#ØØH

P0.7 1 Display-select Decoder CS|DAC WR
P0.6 1 Keypad Column 2
P0.5 1 Keypad Column 1
P0.4 1 Keypad Column 0
P0.3 1 Keypad Row 3
P0.2 1 Keypad Row 2
P0.1 1 Keypad Row 1
P0.0 1 Keypad Row 0
P1.7 1 LED 7|Seg. dp|DAC DB7|LCD DB7
P1.6 1 LED 6|Seg. g|DAC DB6|LCD DB6
P1.5 1 LED 5|Seg. f|DAC DB5|LCD DB5
P1.4 1 LED 4|Seg. e|DAC DB4|LCD DB4
P1.3 1 LED 3|... d|..DB3|..DB3|.. RS
P1.2 1 LED 2|... c|..DB2|..DB2|LCD E
P1.1 1 LED 1|Seg. b|DAC DB1|LCD DB1
P1.0 1 LED 0|Seg. a|DAC DB0|LCD DB0
P2.7 1 SW 7|ADC DB7
P2.6 1 SW 6|ADC DB6
P2.5 1 SW 5|ADC DB5
P2.4 1 SW 4|ADC DB4
P2.3 1 SW 3|ADC DB3
P2.2 1 SW 2|ADC DB2
P2.1 1 SW 1|ADC DB1
P2.0 1 SW 0|ADC DB0
P3.7 1 ADC RD|Comparator Output
P3.6 1 ADC WR
P3.5 1 Motor Sensor
P3.4 1 Display-select Input 1
P3.3 1 AND Gate Output|Display-se..t 0
P3.2 1 ADC INTR
P3.1 1 Motor Control Bit 1|Ext. UART Rx
P3.0 1 Motor Control Bit 0|Ext. UART Tx

DI / LD    1 2 3   AND Gate Disabled    U  No Parity  8-bit UART @ 4800 Baud
```

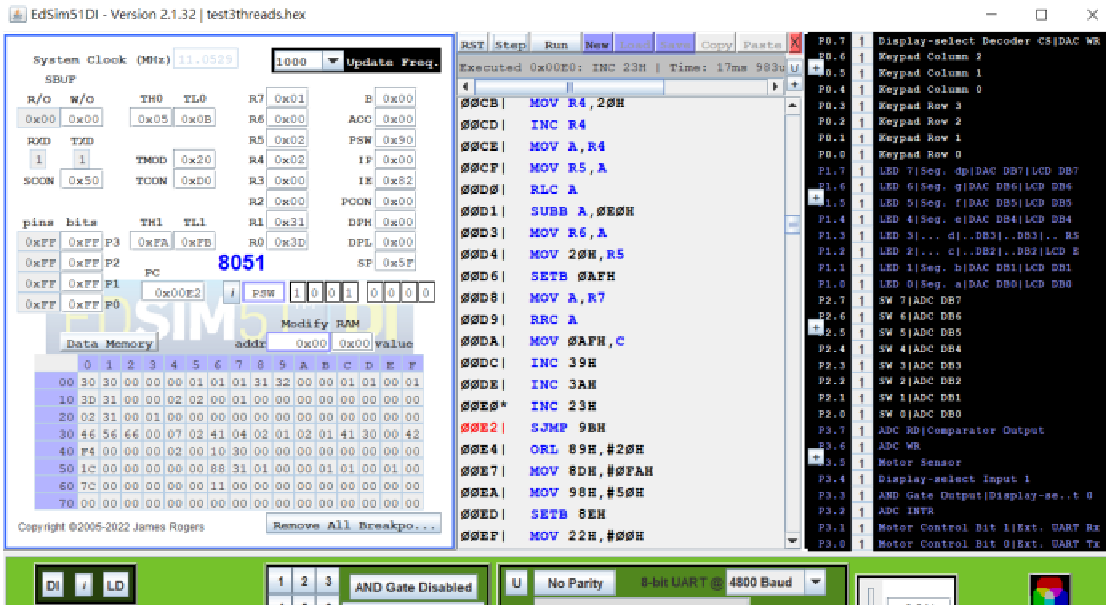

```
EdSim51DI - Version 2.1.32 | test3threads.hex

System Clock (MHz) 11.0592        1000  Update Freq.
SBUF
R/O   W/O     TH0   TL0      R7 0x01       B 0x00
0x00  0x00    0x05  0x0B     R6 0x00     ACC 0x00
RXD   TXD                    R5 0x02     PSW 0x90
1     1       TMOD  0x20     R4 0x02      IP 0x00
SCON  0x50    TCON  0xD0     R3 0x00      IE 0x82
                             R2 0x00    PCON 0x00
pins  bits    TH1   TL1      R1 0x31     DPH 0x00
0xFF  0xFF P3 0xFA  0xFB     R0 0x3D     DPL 0x00
0xFF  0xFF P2             8051            SP 0x5F
0xFF  0xFF P1   PC
0xFF  0xFF P0   0x00E2       PSW 1 0 0 1  0 0 0 0
                             Modify RAM
Data Memory                  addr 0x00  0x00 value

    0  1  2  3  4  5  6  7  8  9  A  B  C  D  E  F
00 30 30 00 00 00 01 01 01 31 32 00 00 01 01 00 01
10 3D 31 00 00 02 02 00 01 00 00 00 00 00 00 00 00
20 02 31 00 01 00 00 00 00 00 00 00 00 00 00 00 00
30 46 56 66 00 07 02 41 04 02 01 02 01 41 30 00 42
40 F4 00 00 00 02 00 10 30 00 00 00 00 00 00 00 00
50 1C 00 00 00 00 00 88 31 01 00 00 01 01 00 01 00
60 7C 00 00 00 00 00 11 00 00 00 00 00 00 00 00 00
70 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00

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RST  Step  Run  New  Load  Save  Copy  Paste
Executed 0x00E0: INC 23H | Time: 17ms 983u

ØØCB|   MOV R4,2ØH
ØØCD|   INC R4
ØØCE|   MOV A,R4
ØØCF|   MOV R5,A
ØØDØ|   RLC A
ØØD1|   SUBB A,ØEØH
ØØD3|   MOV R6,A
ØØD4|   MOV 2ØH,R5
ØØD6|   SETB ØAFH
ØØD8|   MOV A,R7
ØØD9|   RRC A
ØØDA|   MOV ØAFH,C
ØØDC|   INC 39H
ØØDE|   INC 3AH
ØØEØ*   INC 23H
ØØE2|   SJMP 9BH
ØØE4|   ORL 89H,#2ØH
ØØE7|   MOV 8DH,#ØFAH
ØØEA|   MOV 98H,#5ØH
ØØED|   SETB 8EH
ØØEF|   MOV 22H,#ØØH

P0.7 1 Display-select Decoder CS|DAC WR
P0.6 1 Keypad Column 2
P0.5 1 Keypad Column 1
P0.4 1 Keypad Column 0
P0.3 1 Keypad Row 3
P0.2 1 Keypad Row 2
P0.1 1 Keypad Row 1
P0.0 1 Keypad Row 0
P1.7 1 LED 7|Seg. dp|DAC DB7|LCD DB7
P1.6 1 LED 6|Seg. g|DAC DB6|LCD DB6
P1.5 1 LED 5|Seg. f|DAC DB5|LCD DB5
P1.4 1 LED 4|Seg. e|DAC DB4|LCD DB4
P1.3 1 LED 3|... d|..DB3|..DB3|.. RS
P1.2 1 LED 2|... c|..DB2|..DB2|LCD E
P1.1 1 LED 1|Seg. b|DAC DB1|LCD DB1
P1.0 1 LED 0|Seg. a|DAC DB0|LCD DB0
P2.7 1 SW 7|ADC DB7
P2.6 1 SW 6|ADC DB6
P2.5 1 SW 5|ADC DB5
P2.4 1 SW 4|ADC DB4
P2.3 1 SW 3|ADC DB3
P2.2 1 SW 2|ADC DB2
P2.1 1 SW 1|ADC DB1
P2.0 1 SW 0|ADC DB0
P3.7 1 ADC RD|Comparator Output
P3.6 1 ADC WR
P3.5 1 Motor Sensor
P3.4 1 Display-select Input 1
P3.3 1 AND Gate Output|Display-se..t 0
P3.2 1 ADC INTR
P3.1 1 Motor Control Bit 1|Ext. UART Rx
P3.0 1 Motor Control Bit 0|Ext. UART Tx

DI / LD    1 2 3   AND Gate Disabled    U  No Parity  8-bit UART @ 4800 Baud
```
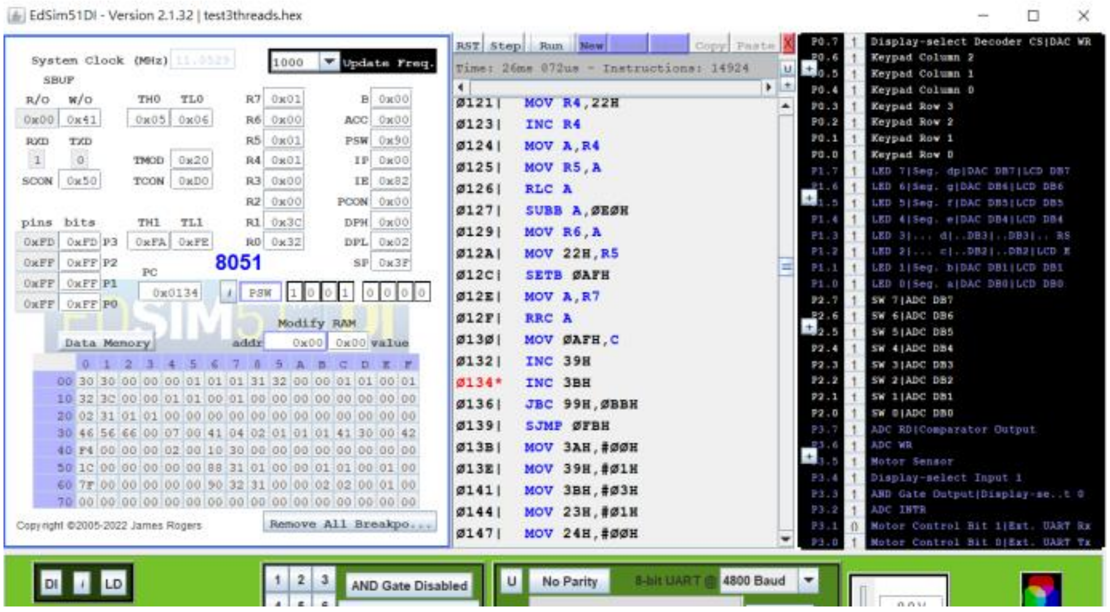
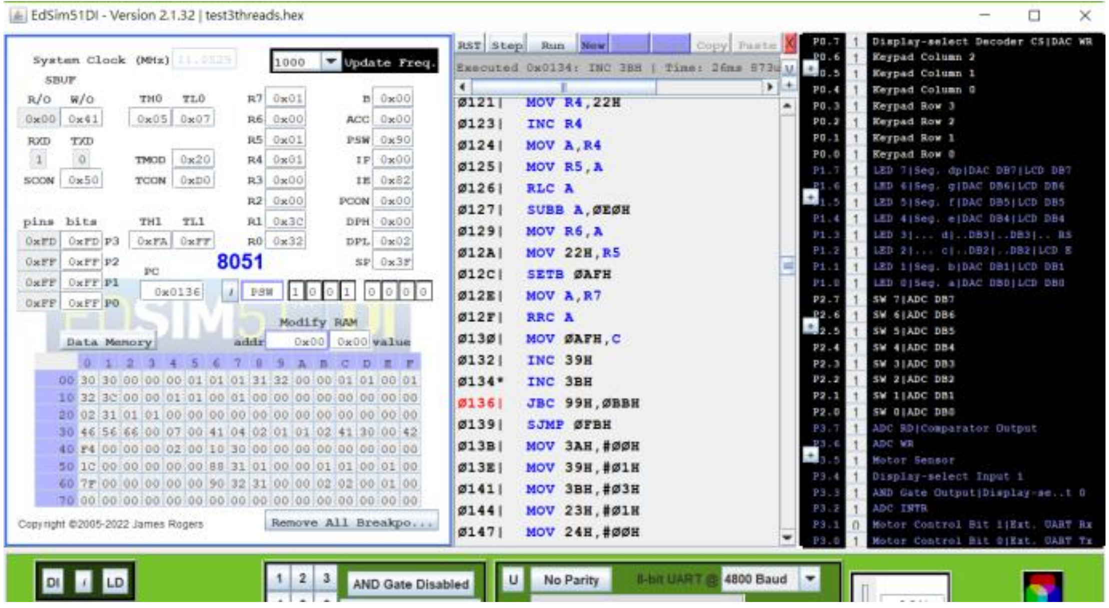

Producer2 is running since the semaphore for preventing starvation "ok1"(at 0x23), (which is used to unlock Producer1) gets increased from 0 to 1.



```
EdSim51DI - Version 2.1.32 | test3threads.hex

System Clock (MHz)  11.0592        1000  Update Freq.
SBUF
R/O   W/O      TH0   TL0     R7 0x01      B 0x00
0x00  0x41     0x05  0x06    R6 0x00    ACC 0x00
RXD   TXD                    R5 0x01    PSW 0x90
 1     0       TMOD  0x20    R4 0x01     IP 0x00
SCON  0x50     TCON  0xD0    R3 0x00     IE 0x82
                             R2 0x00   PCON 0x00
pins  bits     TH1   TL1     R1 0x3C    DPH 0x00
0xFD  0xFD P3  0xFA  0xFE    R0 0x32    DPL 0x02
0xFF  0xFF P2             8051           SP 0x3F
0xFF  0xFF P1    PC
0xFF  0xFF P0    0x0134      PSW  1 0 0 1  0 0 0 0
                                Modify RAM
Data Memory                addr  0x00  0x00 value
    0  1  2  3  4  5  6  7  8  9  A  B  C  D  E  F
00 30 30 00 00 00 01 01 01 31 32 00 00 01 01 00 01
10 32 3C 00 00 01 01 00 01 00 00 00 00 00 00 00 00
20 02 31 01 01 00 00 00 00 00 00 00 00 00 00 00 00
30 46 56 66 00 07 00 41 04 02 01 01 01 41 30 00 42
40 F4 00 00 00 02 00 10 30 00 00 00 00 00 00 00 00
50 1C 00 00 00 00 00 88 31 01 00 00 01 01 00 01 00
60 7F 00 00 00 00 00 90 32 31 00 00 02 02 00 01 00
70 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
Copyright ©2005-2022 James Rogers     Remove All Breakpo...
```

```
RST  Step  Run  New  Copy  Paste
Time: 26ms 072us - Instructions: 14924
Ø121|  MOV R4,22H
Ø123|  INC R4
Ø124|  MOV A,R4
Ø125|  MOV R5,A
Ø126|  RLC A
Ø127|  SUBB A,ØEØH
Ø129|  MOV R6,A
Ø12A|  MOV 22H,R5
Ø12C|  SETB ØAFH
Ø12E|  MOV A,R7
Ø12F|  RRC A
Ø13Ø|  MOV ØAFH,C
Ø132|  INC 39H
Ø134*  INC 3BH
Ø136|  JBC 99H,ØBBH
Ø139|  SJMP ØFBH
Ø13B|  MOV 3AH,#ØØH
Ø13E|  MOV 39H,#Ø1H
Ø141|  MOV 3BH,#Ø3H
Ø144|  MOV 23H,#Ø1H
Ø147|  MOV 24H,#ØØH
```

```
P0.7  1  Display-select Decoder CS|DAC WR
P0.6  1  Keypad Column 2
P0.5  1  Keypad Column 1
P0.4  1  Keypad Column 0
P0.3  1  Keypad Row 3
P0.2  1  Keypad Row 2
P0.1  1  Keypad Row 1
P0.0  1  Keypad Row 0
P1.7  1  LED 7|Seg. dp|DAC DB7|LCD DB7
P1.6  1  LED 6|Seg. g|DAC DB6|LCD DB6
P1.5  1  LED 5|Seg. f|DAC DB5|LCD DB5
P1.4  1  LED 4|Seg. e|DAC DB4|LCD DB4
P1.3  1  LED 3|... d|..DB3|..DB3|.. RS
P1.2  1  LED 2|... c|..DB2|..DB2|LCD E
P1.1  1  LED 1|Seg. b|DAC DB1|LCD DB1
P1.0  1  LED 0|Seg. a|DAC DB0|LCD DB0
P2.7  1  SW 7|ADC DB7
P2.6  1  SW 6|ADC DB6
P2.5  1  SW 5|ADC DB5
P2.4  1  SW 4|ADC DB4
P2.3  1  SW 3|ADC DB3
P2.2  1  SW 2|ADC DB2
P2.1  1  SW 1|ADC DB1
P2.0  1  SW 0|ADC DB0
P3.7  1  ADC RD|Comparator Output
P3.6  1  ADC WR
P3.5  1  Motor Sensor
P3.4  1  Display-select Input 1
P3.3  1  AND Gate Output|Display-se..t 0
P3.2  1  ADC INTR
P3.1  0  Motor Control Bit 1|Ext. UART Rx
P3.0  1  Motor Control Bit 0|Ext. UART Tx
```

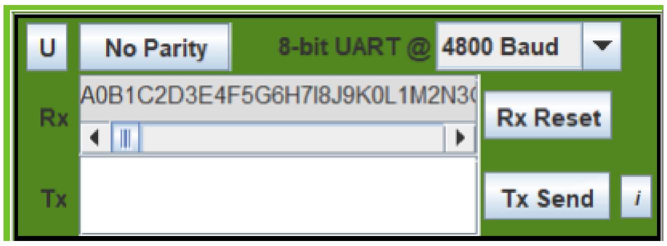


```
EdSim51DI - Version 2.1.32 | test3threads.hex

System Clock (MHz)  11.0592        1000  Update Freq.
SBUF
R/O   W/O      TH0   TL0     R7 0x01      B 0x00
0x00  0x41     0x05  0x07    R6 0x00    ACC 0x00
RXD   TXD                    R5 0x01    PSW 0x90
 1     0       TMOD  0x20    R4 0x01     IP 0x00
SCON  0x50     TCON  0xD0    R3 0x00     IE 0x82
                             R2 0x00   PCON 0x00
pins  bits     TH1   TL1     R1 0x3C    DPH 0x00
0xFD  0xFD P3  0xFA  0xFF    R0 0x32    DPL 0x02
0xFF  0xFF P2             8051           SP 0x3F
0xFF  0xFF P1    PC
0xFF  0xFF P0    0x0136      PSW  1 0 0 1  0 0 0 0
                                Modify RAM
Data Memory                addr  0x00  0x00 value
    0  1  2  3  4  5  6  7  8  9  A  B  C  D  E  F
00 30 30 00 00 00 01 01 01 31 32 00 00 01 01 00 01
10 32 3C 00 00 01 01 00 01 00 00 00 00 00 00 00 00
20 02 31 01 01 00 00 00 00 00 00 00 00 00 00 00 00
30 46 56 66 00 07 00 41 04 02 01 01 02 41 30 00 42
40 F4 00 00 00 02 00 10 30 00 00 00 00 00 00 00 00
50 1C 00 00 00 00 00 88 31 01 00 00 01 01 00 01 00
60 7F 00 00 00 00 00 90 32 31 00 00 02 02 00 01 00
70 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
Copyright ©2005-2022 James Rogers     Remove All Breakpo...
```

```
RST  Step  Run  New  Copy  Paste
Executed 0x0134: INC 3BH | Time: 26ms 873u
Ø121|  MOV R4,22H
Ø123|  INC R4
Ø124|  MOV A,R4
Ø125|  MOV R5,A
Ø126|  RLC A
Ø127|  SUBB A,ØEØH
Ø129|  MOV R6,A
Ø12A|  MOV 22H,R5
Ø12C|  SETB ØAFH
Ø12E|  MOV A,R7
Ø12F|  RRC A
Ø13Ø|  MOV ØAFH,C
Ø132|  INC 39H
Ø134*  INC 3BH
Ø136|  JBC 99H,ØBBH
Ø139|  SJMP ØFBH
Ø13B|  MOV 3AH,#ØØH
Ø13E|  MOV 39H,#Ø1H
Ø141|  MOV 3BH,#Ø3H
Ø144|  MOV 23H,#Ø1H
Ø147|  MOV 24H,#ØØH
```

```
P0.7  1  Display-select Decoder CS|DAC WR
P0.6  1  Keypad Column 2
P0.5  1  Keypad Column 1
P0.4  1  Keypad Column 0
P0.3  1  Keypad Row 3
P0.2  1  Keypad Row 2
P0.1  1  Keypad Row 1
P0.0  1  Keypad Row 0
P1.7  1  LED 7|Seg. dp|DAC DB7|LCD DB7
P1.6  1  LED 6|Seg. g|DAC DB6|LCD DB6
P1.5  1  LED 5|Seg. f|DAC DB5|LCD DB5
P1.4  1  LED 4|Seg. e|DAC DB4|LCD DB4
P1.3  1  LED 3|... d|..DB3|..DB3|.. RS
P1.2  1  LED 2|... c|..DB2|..DB2|LCD E
P1.1  1  LED 1|Seg. b|DAC DB1|LCD DB1
P1.0  1  LED 0|Seg. a|DAC DB0|LCD DB0
P2.7  1  SW 7|ADC DB7
P2.6  1  SW 6|ADC DB6
P2.5  1  SW 5|ADC DB5
P2.4  1  SW 4|ADC DB4
P2.3  1  SW 3|ADC DB3
P2.2  1  SW 2|ADC DB2
P2.1  1  SW 1|ADC DB1
P2.0  1  SW 0|ADC DB0
P3.7  1  ADC RD|Comparator Output
P3.6  1  ADC WR
P3.5  1  Motor Sensor
P3.4  1  Display-select Input 1
P3.3  1  AND Gate Output|Display-se..t 0
P3.2  1  ADC INTR
P3.1  0  Motor Control Bit 1|Ext. UART Rx
P3.0  1  Motor Control Bit 0|Ext. UART Tx
```

Consumer is running since the semaphore “empty”(at 0x3B) gets increased from 1 to 2.



```
U  No Parity  8-bit UART @ 4800 Baud
Rx  A0B1C2D3E4F5G6H7I8J9K0L1M2N3(
Tx
```

Fair version: Producer1 and Producer2 have their own additional mutex ok1 and ok2, which ok1 is initialized to 1 and ok2 is initialized to 0. So after Producer1 has produced a character, it can’t produce the following one until Producer2 increases ok1, so this ensures that two producers will produce characters and numbers in turns one by one, without anyone having starvation.