Government of Karnataka

Department of Technical Education
Board of Technical Examinations, Bengaluru

Course Title: **Microcontroller & Applications**		Course Code	: **15EC42T**
Credits	: **4**	Semester	: **4**
Teaching Scheme in Hrs (L:T:P)	: **4:0:0**	Course Group	: **Core**
Type of course	: **Lecture**	Total Contact Hours	: **52**
CIE	: **25 Marks**	SEE	: **100 Marks**

Prerequisites

Knowledge of digital devices and exposure to programming languages

Course Objectives

To introduce the students to the architectural features of microcontrollers, capabilities of microcontroller and their utilisation.

Course Outcomes

On successful completion of the course, the students will be able to attain the following COs

Course Outcome		CL	Linked POs	Teaching Hours
CO1	Understand the architectural features of MCS-51 variants and select a suitable microcontroller to suit the application.	***R/U/A***	1,2,10	**10**
CO2	Develop programs for control applications using assembly language and embedded C.	***R/U/A***	1,2,3,4,10	**10**
CO3	Use timers and counters for delay generation and event counting.	***R/U/A***	1,2,3,4,10	**09**
CO4	Illustrate the use of interrupts and service routines	***R/U/A***	1,2,3,4,10	**08**
CO5	Write algorithms and develop programs for serial data communication applications.	***U/A***	1,2,10	**08**
CO6	Design microcontroller based-applications for simple real-world applications.	***U/A***	1,2,3,4,10	**07**
			Total	**52**

Legends: PO-Program Outcome, CO-Course Outcome, CL-Cognitive Level, R-Remember, U-Understand, A-Apply

Course-PO attainment matrix

Course	Programme Outcomes									
	1	2	3	4	5	6	7	8	9	10
Microcontroller & Applications	**3**	**3**	**3**	**3**	--	--	--	--	--	**3**

Level 3- Highly Addressed, Level 2-Moderately Addressed, Level 1-Low Addressed.

Method is to relate the level of PO with the number of hours devoted to the COs which address the given PO.
If ≥40% of classroom sessions addressing a particular PO, it is considered that PO is addressed at Level 3
If 25 to 40% of classroom sessions addressing a particular PO, it is considered that PO is addressed at Level 2
If 5 to 25% of classroom sessions addressing a particular PO, it is considered that PO is addressed at Level 1
If < 5% of classroom sessions addressing a particular PO, it is considered that PO is considered not-addressed.

Course content and pattern of marks for SEE

Unit	Unit Name	Teaching Hours	Weightage for CLs in SEE			Marks	Weightage (%)
			R	U	A		
1	8051 Architecture	**10**	05	05	15	25	19
2	Assembly language programming	**10**	05	05	20	30	19
3	Embedded C	**09**	05	10	10	25	18
4	I/O port and Interrupts programming	**08**	05	10	10	25	15
5	Timers /Counters and Serial I/O	**08**	05	05	10	20	15
6	Interfacing the 8051	**07**	05	05	10	20	14
	Total	**52**	**30**	**40**	**75**	**145**	**100**

Legend: R- Remember, U-Understand A-Application

Course Contents

Unit - 1: 8051 Architecture 10 Hours

Introduction to the concepts of microprocessors, microcontrollers, RISC, CISC, Harvard and Von Neumann architectures. Selection of microcontrollers, variants of MCS-51 family and their features. Applications of microcontrollers. Architecture of 8051 and its pin details. PC, DPTR, A & B registers, PSW register-flag bits, SFRs, Memory organization, general purpose RAM, bit addressable RAM, register banks, interfacing external data and code memory.

Unit - 2: Assembly language programming 10 Hours

Features of machine language, assembly language, middle-level and high-level languages. 8051 Addressing modes. Instruction set: Classification, syntax and function of instructions, example programs.

Unit – 3: Embedded C 9 Hours

Introduction to embedded C and its applicability to 8051, its pros and cons, general structure of embedded C program, data types, memory types and models, pointers, pointer's memory type,

typed and untyped pointers. Time-delay generation using loops, accessing SFRs and bit addressable RAM, arithmetic and logical operators, example programs.

Unit - 4: I/O port and Interrupts programming 08 Hours

Features of I/O ports. Byte size I/O, bit addressability and configuring I/O ports, interface I/O devices such as LED, buzzer, push-button switch, relay, example programs with assembly & C. Polling & interrupt methods, executing an interrupt, different types, IE and IP registers, enabling, disabling and priority setting, example programs in assembly and C.

UNIT -5: Timers /Counters and Serial I/O 08 Hours

Bit structure and function of TMOD and TCON registers, mode 1 & mode 2 operations of timers and counters, time delay generation & example programs in assembly and C.

Bit structure and function of SCON register, SBUF register, TI and RI flags, working of serial port, connecting 8051 to RS 232, serial data transmission and reception, example programs in assembly and C.

UNIT- 6: Interfacing the 8051 07Hours

Multiplexed seven-segment display, LCD module, ADC 0804, wave form generation using DAC 0808, DC motor-PWM for speed control, Stepper motor, appropriate schematic, and algorithm and C programs.

References

1. *The 8051 Microcontroller & Embedded systemsusing assembly and C (2nd Edition)* –M.A.Mazidi , J.C. Mazidi & R.D.McKinlay ISBN: 81-317-1026-2
2. *The 8051 Microcontroller(4th Edition)*- MacKenzie , ISBN:81-317-2018-7
3. *The 8051 Microcontroller(1st Edition*) – Dr.Uma Rao & Andhe Paallavi, ISBN: 81-317-3252-5
4. *Microcontrollers & applications*, Ramani Kalpathi, & Ganesh Raja , ISBN: 81-888-4918-9
5. Embedded C - Michael .J.Pont - Pearson Education -2002 ISBN 0 201 79523 X

Course Delivery

The course will be delivered through lectures, presentations and support of modern tools. Student activities are off-class.

Course Assessment and Evaluation Scheme

Master Scheme

Assessment Method	What		To Whom	Assessment mode /Frequency /timing	Max. Marks	Evidence Collected	Course Outcomes
Direct assessment	CIE	IA	Students	Three tests+	**20**	Blue Books	1 to 6
				Activity*	**05**	Activity Sheets	1 to 6
	SEE	End exam		End of the course	**100**	Answer Scripts at BTE	1 to 6
				Total	**125**		
Indirect assessment	Student feedback on course		Students	Middle of the Course	Nil	Feedback Forms	1 to 3 Delivery of course
	End of course survey			End of the Course	Nil	Question-naires	1 to 6 Effectiveness of delivery instructions & assessment methods

Legends: CIE-Continuous Internal Evaluation, SEE- Semester End-exam Evaluation

+ Every I.A. test shall be conducted for 20 marks. Average of three tests, by rounding off any fractional part thereof to next higher integer, shall be considered for IA.

***S**tudents should do activity as per the list of suggested activities/ similar activities with prior approval of the teacher. Activity process must be initiated well in advance so that it can be completed well before the end of the term.

Questions for CIE and SEE will be designed to evaluate the various CLs as per the weightage shown in the following table.

Sl. No.	Cognitive Levels (CL)	Weightage (%)
1	Remembering	20
2	Understanding	30
3	Applying	50
	Total	**100**

Continuous Internal Evaluation (CIE) pattern

(i) Student Activity (5 marks)

The following student activities or similar activities can be assigned for assessing CIE/IA marks

Sl. No.	Activity	Weightage
1	Collection of features and pin diagrams of at least three controllers from following families. (1) PIC microcontrollers, (2) AVR microcontrollers, (3) ARM microcontrollers, (4) Intel microcontrollers (other than MCS-51), (5) Any other microcontroller family	50%
2	Prepare the block diagram of any one of the following real-world control application based on microcontroller. (1)Temperature control, (2) Weighing machine, (3) Humidity control, (4) Public telephone (Land-line), (5) Street-light control, (7) Washing machine control, (9) Any other application of similar nature and magnitude	

Execution Mode

1. Activity 1 and 2 are mandatory for every batch; every batch can have maximum of 2 students.
2. Activities shall be carried out batch-wise throughout the semester and submit the report per batch before the end of the semester.
3. Report shall be qualitative and not to exceed 4 pages.
4. Each of the activity can be carried out off-class; however, demonstration/presentation should be done in the class room.
5. Teacher is expected to observe and record the progress of students' activities
6. Assessment shall be made based on quality of activity in accordance with the following **rubrics** table.

(ii) Model of rubrics for assessing student activity (for every student)

Dimension	Scale					Marks (Example)
	1 Unsatisfactory	2 Developing	3 Satisfactory	4 Good	5 Exemplary	
1. Research and gathering information	Does not collect information relate to topic	Collects very limited information, some relate to topic	Collects basic information, most refer to the topic	Collects more information, most refer to the topic	Collects a great deals of information, all refer to the topic	3
2. Full-fills team roles and duties	Does not perform any duties assigned to the team role	Performs very little duties	Performs nearly all duties	Performs almost all duties	Performs all duties of assigned team roles	2
3. Shares work equality	Always relies on others to do the work	Rarely does the assigned work, often needs reminding	Usually does the assigned work, rarely needs reminding	Always does the assigned work, rarely needs reminding.	Always does the assigned work, without needing reminding	5
4. Listen to other team mates	Is always talking, never allows anyone to else to speak	Usually does most of the talking, rarely allows others to speak	Listens, but sometimes talk too much,	Listens and talks a little more than needed.	Listens and talks a fare amount	3
					Total marks	ceil(13/4)= 4

(iii) CIE/IA Tests (20 Marks)

Three tests have to be conducted in accordance with the test pattern given below and average marks of them are considered for CIE/IA with specified schedule. Fractional average marks can be rounded-off to next higher integer.

(iv) Format of CIE/IA test question paper

CIE Question Paper							
Institution Name and Code							
Course Coordinator/Teacher							
Program Name		***Test No.***		*Units*			
Class/Sem		*Date*		*CL*			
Course Name		*Time*		*COs*			
Course Code		*Max. Marks*		*POs*			
Note to students: Answer all questions							
Question No.	**Question**		Marks	**CL**	**CO**	**PO**	
1							
2							
3							
4							

Legends: PO-Program Outcome, CO-Course outcome, CL-Cognitive Level, R-Remember, U-Understand, A-Apply

Note: Internal choice may be given in each CO at the same cognitive level (CL).

(v) Model question paper for CIE

CIE Question Paper					
Institution Name and Code					
Course Coordinator/Teacher					
Program Name	Electronics and Communication	***Test No.***	1	*Units*	1 & 2
Class/Sem	3rd Sem	*Date*	1/1/2017	*CL*	R/U/A
Course Name	Microcontroller & Applications	*Time*	10-11AM	*COs*	1 & 2
Course Code	**15EC42T**	*Max. Marks*	20	*POs*	1, 2 & 3

Note to students: Answer all questions

No.	**Question**	Marks	**CL**	**CO**	**PO**
1	Explain the significance of PSW of 8051	05	U/A	1	1,2,3
2	List the features of 8051 microcontroller OR Write the instructions to select (i) register bank 0 and (ii) register bank 3	05	R/A	1	1,2
3	Classify the instruction set of 8051	05	U	2	1,2
4	Point out the mistake in the following instructions (i) PUSH R1 (ii) MOV R1,#398 (iii) RET label (iv) MOV R1,R2 (v) DIV A,B OR Write an ALP to convert ASCII to Hexadecimal	05	A	2	1,2

Semester End-exam Evaluation (SEE)

(i) End-exam question-paper pattern

Unit	Unit Name	Study Duration (Hrs.)	No. Questions for end-exam	
			PART – A 5 Marks	PART – B 10 Marks
1	8051 Architecture	10	01	02
2	Assembly language programming	10	02	02
3	Embedded C	09	01	02
4	I/O port and Interrupts programming	08	01	02
5	Timers /Counters and Serial I/O	08	02	01
6	Interfacing the 8051	07	02	01
	Total	**52**	**09 (45 Marks)**	**10 (100 Marks)**

(ii) Model question paper

Course Title **: MICROCONTROLLERS AND APPLICATIONS**

Course Code **: 15EC42T** Time **: 3 Hrs**

Semester **: Third** Max. Marks**: 100**

Instructions*: 1. Answer any **SIX** question from **Part A** (5x6=30 Marks)*

*2. Answer any **SEVEN** full questions from **Part B** (7x10=70 Marks)*

Part A

1. Compare the features of Harvard and von-Neumann architectures
2. Indicate the uses of the following instructions (i) NOP (ii) XRL (iii) ORL (iv) ANL (v) RETI
3. Write an ALP the average of 5 marks stored in internal RAM. Assume the maximum marks to be 50.
4. Write C statements to do the following tasks
   (i) To right shift the contents of P3 by 4 bit positions
   (ii) To set the d1 and d3 bit of P1
5. Discuss the interrupt priority order achieved by the execution of MOV IP,#11H instruction
6. Calculate the values that are to be loaded into TH1 In order to get the following baud rates (i) 2400 (ii) 9600
7. Summarize the scheme of interfacing RS232 to 8051
8. Write the schematic for interfacing ADC 0804 to 8051
9. Sketch the schematic for interfacing a 8X2 alphanumeric LCD to 8051 in 8 bit data mode

Part B

1. Explain the internal RAM organization of 8051
2. Describe the method of interfacing 4K data RAM to 8051 microcontroller
3. Explain any 5 single bit instructions of 8051
4. Write an ALP to find the smallest of n 8bit numbers
5. (a) Write a C program to read P1.2 and send it to P2.3 after inverting it.
   (b) Write a 8051 C program to convert unpacked BCD to ASCII and to display it on P0
6. (a) Write a 8051 C program to convert a 8 bit hexadecimal number to ASCII after converting it to unpacked BCD and to display the ASCII digits on P0,P1 and P2

(b) The data stored in RAM are 25h,22h,3fh,52h and E8h where E8 is the check sum byte. Write a 8051 C program to check the data integrity. If data is good send ASCII character 'G' to P0 otherwise send 'B'

7. Write the schematic, algorithm and a program for 8051 to sense the push button switch and accordingly control the on/off of LED
8. Summarize the different interrupts of 8051 w.r.t the method of their activation and IVL
9. Write an ALP and a8051 C program to generate a time delay of 50mS. Use timer1 in mode1 and a crystal frequency of 12MHz
10. Write the schematic, algorithm and a program to interface a DAC to 8051 and to generate a triangular waveform
11.

Institutional activities (No marks)

The following are suggested institutional activities, to be carried out at least one during the semester. The course teacher/coordinator is expected to maintain the relevant record (Containing, Activity name, Resource persons and their details, duration, venue, student feedback, etc) pertaining to Institutional activities.

Sl. No.	Activity
1	Organize seminar workshop or lecture from experts on the modern trends in microcontrollers
2	Motivate students to take case study on different microcontroller-based mini projects (small applications such as applications specified in student activity) to inculcate self and continuous learning

Model Question Bank

Note: The questions in the question bank are indicative but not exhaustive. Sub-questions on different CLs may be combined in 10-marks questions or 10-marks questions can be splitted into if necessary keeping weightage of CLs approximately intact.

Unit-1

5-Mark questions

1. List the features of 8051 microcontroller
2. Differentiate between a microcontroller and microprocessor
3. Compare the features of Harvard and von-Neumann architectures
4. Compare the features of RISC and CISC
5. Explain the significance of PSW of 8051
6. List the functions of any 5 SFRs
7. List the points to be considered during the selection of a microcontroller for an application
8. Name the pins of 8051 used for external memory interfacing and list their functions.
9. List the functions of conditional and user flags of 8051
10. Identify to which M.L , the data is moved after the execution of the following program segment

```
SETB RS1
CLR RS0
MOV R1,#25h
MOV R3,#65h
```

11. Write the instructions to select (i) register bank 0 and (ii) register bank 3

10-Mark questions

1. Explain the architecture of 8051 microcontroller
2. List the functions of different pins of 8051
3. Describe the method of interfacing 2K data RAM to 8051 microcontroller
4. Describe the method of interfacing 4K data RAM to 8051 microcontroller
5. Describe the method of interfacing 8K PROM to 8051 microcontroller
6. Explain the functions of regA, regB, PC,SP and DPTR
7. Explain the internal RAM organization of 8051

Unit-2

5-Mark questions

1. Identify the addressing modes of the following instructions (i) PUSH (ii) MOV A,R1 (iii) MOV A,@R1 (iv) JNC AHEAD (v) MOV A,@A + PC
2. Differentiate between an assembly instruction and assembler directive
3. Classify the instruction set of 8051
4. Indicate the uses of the following instructions (i) NOP (ii) XRL (iii) ORL (iv) ANL (v) RETI
5. Point out the mistake in the following instructions (i) PUSH R1 (ii) MOV R1,#398 (iii) RET label (iv) MOV R1,R2 (v) DIV A,B
6. Explain the different branch address ranges supported by 8051 instructions
7. Write an ALP to transfer a block of data from one portion of internal RAM to another
8. Write an ALP the average of 5 marks stored in internal RAM. Assume the maximum marks to be 50.
9. Write an ALP to convert ASCII to Hexadecimal
10. Write an ALP to convert hexadecimal to ASCII

10-Mark questions

1. Explain the addressing modes of 8051
2. Explain any 5 conditional branch instructions of 8051
3. Explain any 5 single bit instructions of 8051
4. Write an ALP to find the largest of n 8bit numbers
5. Write an ALP to find the smallest of n 8bit numbers
6. Write an ALP to arrange a list 8bit numbers in ascending order
7. Write an ALP to arrange a list 8bit numbers in descending order
8. Write an ALP to search for a given 8bit number in a list of n 8 bit numbers

Unit-3

5-Mark questions

1. List the advantages and disadvantages of using 8051 C
2. Show how octal, hexadecimal and decimal numbers are represented in 8051 C
3. Explain the different logical operators available in 8051C
4. Explain the different arithmetic operators available in 8051C
5. Explain the different data types available in 8051C
6. Explain the different memory models available in 8051C
7. Explain the different memory type specifiers available in 8051C
8. Write C statements to do the following tasks
   (i) To toggle the content of P0
   (ii) To left shift the content of P2 by 2 bit positions
9. Write C statements to do the following tasks
   (i) To mask the d3 and d5 bits of P0
   (ii) To toggle the d7 and d3 bit of P2
10. Write C statements to do the following tasks
    (i) To mask the d3 and d5 bits of P0
    (ii) To toggle the d7 and d3 bit of P2
11. Write C statements to do the following tasks
    (iii) To right shift the contents of P3 by 4 bit position
    (iv) To set the d1 and d3 bit of P1

10-Mark questions

1. (a) Write a C program to read P1.2 and send it to P2.3 after inverting it.
   (b) Write a 8051 C program to convert unpacked BCD to ASCII and to display it on P0
2. (a)Write a 8051 C program to toggle all the bits of P0 for every 500ms
   (i) by using NOT operator (ii) by using EX-OR operator
   (b) Write a 8051 C program to convert ASCII into unpacked BCD and send it to P0
3. (a)Write a 8051 C program to do the following (i) Clear P0 contents using EX -OR (ii) Set D4 bit of memory location temp1 without affecting other bits (iii) Mask D5 and D3 bits of memory location temp2
   (b) (b)Write a 8051 C program to read P1.0 and P1.1 bits and send ASCII characters '0','1','2' and '3' to P0 for the combination 00,01,10 and 11 of P1.1 and P1.0 bits
4. (a) Write a 8051 C program to convert packed BCD to ASCII and to display it on P1 and P2
   (b) Write a 8051 C program to convert ASCII digits '4' and '7' into packed BCD and to display on port P1
5. (a) Write a 8051 C program to convert a 8 bit hexadecimal number to unpacked BCD and to display it on P0,P1 and P2
   (b) Write a 8051 C program to output the checksum byte for the 4 bytes of data 25h,62h,3fh and 52h on to port P3
6. (a) Write a 8051 C program to convert a 8 bit hexadecimal number to ASCII after converting it to unpacked BCD and to display the ASCII digits on P0,P1 and P2
   (b) The data stored in RAM are 25h,22h,3fh,52h and E8h where E8 is the check sum byte. Write a 8051 C program to check the data integrity. If data is good send ASCII character 'G' to P0 otherwise send 'B'

Unit-4

5-Mark questions

1. List the advantages and disadvantages of using an interrupt
2. Compare the interrupt method and polling method of servicing devices
3. Differentiate between an ISR and a subroutine
4. Explain the bit structure of IP register
5. Explain the bit structure of IE register
6. List the steps involved in executing an interrupt
7. Explain the method of enabling only timer interrupts and disabling others
8. Explain the method of enabling only external hardware interrupts and disabling others
9. Discuss the interrupt priority order achieved by the execution of MOV IP,#11H instruction
10. Differentiate between RET and RETI
11. List the interrupts of 8051 and their vector locations

10-Mark questions

1. Summarize the different interrupts of 8051 w.r.t the method of their activation and IVL
2. Write the schematic, algorithm and a program for 8051 to sense the push button switch and accordingly control the on/off of LED
3. Write an algorithm and a C program to monitor the door sensor connected to the pin P1.1 when the door opens sound the buzzer connected to P1.7. The buzzer is to be sounded by sending a square wave of a few 100Hz
4. Write an ALP and a C program to send values 0 to 4 to port P2
5. Write an ALP and a C program to toggle bit 1 of Port 0 25000times
6. Write an ALP and a C program to continuously send 00h to 20h to port P0
7. Write an ALP and a C program to toggle the bits of port P3 continuously
8. Write an ALP and a C program to display the ASCII values characters 0,1,A and B on port P2 only once
9. Write an ALP and a C program to toggle the bit 1 of port P0 continuously

10. Unit-5

5-Mark questions

1. Differentiate between timers and counters
2. Explain the features of timer0 and timer1 registers
3. Explain the significance of SBUF register
4. Explain the significance of SI and RI flags
5. Calculate the values that are to be loaded into TH1 In order to get the following baud rates (i) 2400 (ii) 9600
6. List the steps involved in serial data transmission
7. List the steps involved in serial data reception
8. Summarize the scheme of interfacing RS232 to 8051
9. Explain the uses of TCON register
10. Explain how a programmer select external hardware interrupts as level triggered interrupts
11. Explain how a programmer select external hardware interrupts as edge triggered interrupts
12. Explain the operation of timer0 in mode 1
13. Explain the operation of timer1 in mode 2
14. Explain the operation of counter0 in mode 1

10-Mark questions

1. Explain the bit structure of TMOD register
2. Explain the bit structure of SCON register
3. Write an ALP to receive data serially at a baud rate of 4800 and send the received data to R1
4. Write an ALP to receive data serially at a baud rate of 9600 and send the received data to P1
5. Write an ALP to transmit the letter 'A' serially at a baud rate of 2400
6. Write an ALP to transmit the message "YES" serially at a baud rate of 4800
7. Write an ALP and a8051 C program to generate a time delay of 50mS. Use timer1 in mode1 and a crystal frequency of 12MHz.
8. Write an ALP and a8051 C program to generate a square wave of on period 100microseconds and an off period of 100microseconds at P1.2 . Use timer0 in mode 2 and a crystal frequency of 12MHz.
9. Write an ALP and a8051 C program to generate a square wave of 10KHz at P1.2 . Use timer1 in mode 2 and a crystal frequency of 10MHz
10. Write an ALP and a8051 C program to generate a square wave of 25% duty cycle and an on period of 10mS at P1.4 . Use timer0 in mode 1 and a crystal frequency of 12MHz
11. Write an ALP and a C program to read the content of P0 and send it to P1 after a time delay of 100mS. Use a crystal frequency of 12MHz

Unit-6

5-Mark questions

1. Write the schematic for interfacing a 4 digit multiplexed 7 segment display to 8051
2. Write the schematic for interfacing ADC 0804 to 8051
3. Sketch the schematic for interfacing DC motor to 8051
4. Sketch the schematic for interfacing a 8X2 alphanumeric LCD to 8051 in 4 bit data mode
5. Sketch the schematic for interfacing a 8X2 alphanumeric LCD to 8051 in 8 bit data mode
6. Sketch the schematic for interfacing a stepper motor to 8051
7. List the pins of alphanumeric LCD module which help in interfacing with the microcontroller.

10-Mark questions

1. Write the schematic, algorithm and a program to interface 4 digit multiplexed 7 segment display to 8051 and display 2016

2. Write the schematic, algorithm and a program to interface a stepper motor to 8051 and to rotate the motor in anti clock wise direction using wave drive sequence
3. Write the schematic, algorithm and a program to interface a stepper motor to 8051 and to rotate the motor in clock wise direction using normal 4 step sequence
4. Write the schematic, algorithm and a program to interface a DC motor to 8051 and to run the motor with 35% duty cycle
5. Write the schematic, algorithm and a program to interface a alphanumeric LCD to 8051 and to display 'INDIA'
6. Write the schematic, algorithm and a program to interface a DAC to 8051 and to generate a triangular waveform
7. Write the schematic, algorithm and a program to interface a ADC 0804 to 8051

End