MICROCONTROLLER AND EMBEDDED SYSTEMS

LABORATORY MANUAL (ECE - 327)

III/IV ECE SEM - II

By
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DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

ANIL NEERUKONDA INSTITUTE OF TECHNOLOGY & SCIENCES (A)
(Affiliated to AU, Approved by AICTE & Accredited by NBA) Sangivalasa-531 162, Visakhapatnam District, Phone: 08933-225083/84/87

Vision of the Institute

ANITS envisions to emerge as a world-class technical institution whose products represent a good blend of technological excellence and the best of human values.

Mission of the Institute

To train young men and women into competent and confident engineers with excellent communication skills, to face the challenges of future technology changes, by imparting holistic technical education using the best of infrastructure, outstanding technical and teaching expertise and an exemplary work culture, besides molding them into good citizens

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

Vision of the Department

To become a centre of excellence in Education, research and produce high quality engineers in the field of Electronics and Communication Engineering to face the challenges of future technological changes.

Mission of the Department

To achieve vision department will

Transform students into valuable resources for industry and society by imparting contemporary technical education.

Develop interpersonal skills and leadership qualities among students by creating an ambience of academic integrity to participate in various professional activities

Create a suitable academic environment to promote research attitude among students.

Program Educational Objectives (PEOs):

PEO1 : Graduates excel in their career in the domains of Electronics, Communication and Information Technology.

PEO2 : Graduates will practice professional ethics and excel in professional career through interpersonal skills and leadership qualities.

PEO3 : Graduates demonstrate passion for competence in higher education, research and participate in various professional activities.

Program Outcomes (POs):

Engineering Graduates will be able to:

1. **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. **Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. **Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4. **Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5. **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
6. **The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
7. **Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8. **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

9. **Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10. **Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
11. **Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
12. **Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Program Specific Outcomes (PSOs):

PSO1 : Implement Signal & Image Processing techniques using modern tools.

PSO2 : Design and analyze Communication systems using emerging techniques.

PSO3 : Solve real time problems with expertise in Embedded Systems.

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING
Anil Neerukonda Institute of Technology & Sciences (Autonomous)
Sangivalasa-531 162, Bheemunipatnam Mandal, Visakhapatnam

MICROCONTROLLER AND EMBEDDED SYSTEMS LABORATORY	
ECE 327	Credits:2
Instruction: 3 Practical /Week	Sessional Marks:50
End Exam: 3 Hours	End Exam Marks:50

COURSE OUTCOMES

At the end of the course student will be able to	
1.	Program 8051 microcontroller to meet the requirements of the user
2.	Interface peripherals like switches, LEDs, stepper motor, Traffic lights controller, etc..,
3.	Apply concept & types of interrupts for the given context.
4.	Design a microcontroller development board to meet the requirements of the user

Mapping of Course Outcomes with Program Outcomes:

		PO												PSO		
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO	**1**	3	2	2	2	3			1	1	1				2	2
	2	3	2	2	2	3			1	1	1				3	2
	3	3	2	2	2	3			1	1	1				2	2
	4	3	2	2	2	3	2		1	1	1	1			3	3

3: high correlation, 2: medium correlation, 1: low correlation

MICROCONTROLLER AND EMBEDDED SYSTEMS LABORATORY
LIST OF EXPERIMENTS

NOTE:
1. It is compulsory for each student to create their own Microcontroller Development Board for personal use.
2. A student has to perform a minimum of 10 experiments.

Scheme of Evaluation

(MICROCONTROLLER AND EMBEDDED SYSTEMS LABORATORY)

Total marks for each student to evaluate in lab: 100

Out of 100 marks:

1. **External Evaluation: 50 marks**
2. **Internal Evaluation: 50 marks**
   a. **Internal Lab exam: 20 marks**
   b. **Continuous Evaluation : 30 marks**

Internal Evaluation: 50M

I. **Observation – 5M**
(Successful Wording/Algorithm/flowchart-1M, Successful Program verification – 1M, Successful Program Execution – 1M, Record Initial and Indexing – 2M)

II. **Record – 10M**
(Aim&Apparatus – 1M, Theory – 3M, Algorithm/flowchart – 2M(each experiment should have atleast one flowchart, Calculations, Input/Output observations & Result – 1M, Daily Performance 3M)

III. **Lab Project – 10M**
(It is compulsory for each student to create their own Microcontroller Development Board for personal use based on 8051)

IV. **Attendance – 5M**

V. **Internal Lab Exam – 20M**
(Aim, Apparatus – 2M, Program – 10M (Mnemonics/code – 5M, Relevant Comments – 2M, Algorithm/flow chart – 3M), Calculations, Input/Output observations & Result – 5M, Performance – 3M)

External Evaluation: 50M

I. Write up – 10M
(Aim– 2M, Apparatus – 1M, Theory – 2M, Algorithm/flowchart – 5M)

II. Program – 15M
(Mnemonics/Code – 10M, Comments – 3M, Optimization– 2M)

III. Performance – 5M
(Experimentation skill - Connections,.etc)

IV. Result – 10M
(Identifying & Showing the inputs and outputs – 2M and/or theoretical calculations – 2M, Output Verification – 6M (Partial output – 3M, No Output – 0M)

V. Viva – 10M

RUBRICS

(MCES LABORATORY)

S.No	Competency	Performance Indicator
1	Demonstrate an ability to conduct experiments consistent with their level of knowledge and understanding.	Laboratory preparation (verification of Lab observation)
		Stating clearly the aim of the experiment, its scope and importance for purpose of doing experiment.(Based on viva)
		Experimental procedures (Based on contents in Lab observation)
		Ability to construct the circuit diagram on a bread board and use meters/ instruments to record the measured data according to the range selected.(Based on physical observation)
2	Demonstrate an ability to design experiments to get the desired output.	Finding the appropriate values of the components to meet the specifications.
3	Demonstrate an ability to analyze the data and reach valid conclusions.	Ability to gather materials and writing in lab record (Based on lab record)

S.No	Performance Indicator	Excellent (A) 100%	Good(B) 80%	Need improvement (C) 60%	Fail (D) <40%
1	Laboratory preparation (verification of Lab observation) (5M)	Read and understand the lab manual before coming to lab. Observations are completed with necessary theoretical calculations including the use of units and significant figures	Analyze data for trends and correlations, stating possible errors and limitations in choosing the component values.	Observations are incomplete	No effort exhibited
2	Experimental procedures Conclusions of the lab experiment performed. (Based on physical observation, contents of lab	Clearly describes the purpose of doing experiment and its scope. Follow the given experimental procedures, to obtain the desired output. Able to correlate the theoretical concepts with the concerned	Tabulate data (tabular form or in graphical form) from the results so as to facilitate analysis and explanations of the data, and draw	Some idea of doing experiment but not very clear. Lacks the appropriate knowledge of the lab procedures.	No effort exhibited

	record, viva)(5M)	lab results with appropriate reasons	conclusions. Follow the given experimental procedures, but obtained results with some errors. Able to correlate the theoretical concepts with the concerned lab results with some difficulties.	Has no idea what to do Not able to correlate the theoretical concepts with the concerned lab results	
3	Ability to write a code and verify its output.(Based on physical observation)(5M)	Able to perform tasks accurately without assistance , obtain the stimuli after calculations	Able to perform tasks with some Difficulties, obtain the correct stimuli for only few components after calculations	Poor in performing tasks without assistance, obtain the incorrect stimuli.	No effort exhibited
4	Presentation of record (Based on Lab record)(5M)	Well-organized, interesting, confident presentation of record	Presentation of record acceptable	Presentation of record lacks clarity and organized	No effort exhibited
5	Oral Presentation (Based on Viva)(5M)	Responds confidently, and precisely in giving answers to questions correctly	Responds in giving answers to questions but some answers are wrong.	Responds in giving answers to questions but all answers are wrong.	No effort exhibited

The objective of this lab is to impart skill (both Programming-Assembly level & Hardware) in designing microcomputer systems. This Lab has 8085, 8086 microprocessor trainer kits and 8051 micro controller trainer kits along with interfacing modules to demonstrate the detailed applications of microprocessors& microcontrollers.

The facilities in the laboratory enable students to build a firm background in microcomputer hardware as well as software. Students learn about assembly language programming, memory and I/O design, interfacing of programmable chips and peripherals such as stepper motors, analog – to – digital and digital – to – analog converters etc.

LIST OF MAJOR EQUIPMENT IN MP & MC LABORATORY

S.NO	NAME OF THE EQUIPMENT	MAKE	QUANTITY
1.	Intel 8085 Microprocessor kits	ESA	23
2.	8086 Microprocessor kits	ESA	15
3.	8051 Microcontroller kits	ESA	15
4.	Universal Programmer (iup-uxp)	ESA	01
5.	20MHz Dual trace Oscilloscopes	APLAB	04
6.	PC Systems	HCL	12

TOTAL EXPENDITURE OF THE LABORATORY: Rs. 10,75,309.97/-

Microprocessors and Microcontrollers Laboratory

Do's

1. Proper dress code has to be maintained while entering in to the Lab.
2. Students should carry observation notes and record completed in all aspects.
3. Assembly level program and its theoretical result should be there in the observation before coming to the next lab.
4. Student should be aware of next ALPs.
5. Students should be at their concerned desktop/bench, unnecessary moment is restricted.
6. Student should follow the procedure to start executing the ALP they have to get signed by the Lab instructor for theoretical result then with the permission of Lab instructor they need to switch on the desktop and after completing the same they need to switch off and keep the chairs properly.
7. After completing the ALP Students should verify the ALP by the Lab Instructor.
8. The Practical Result should be noted down into their observations and result must be shown to the Lecturer In-Charge for verification.
9. Students must ensure that all switches are in the OFF position, desktop is shut down properly.

Don'ts

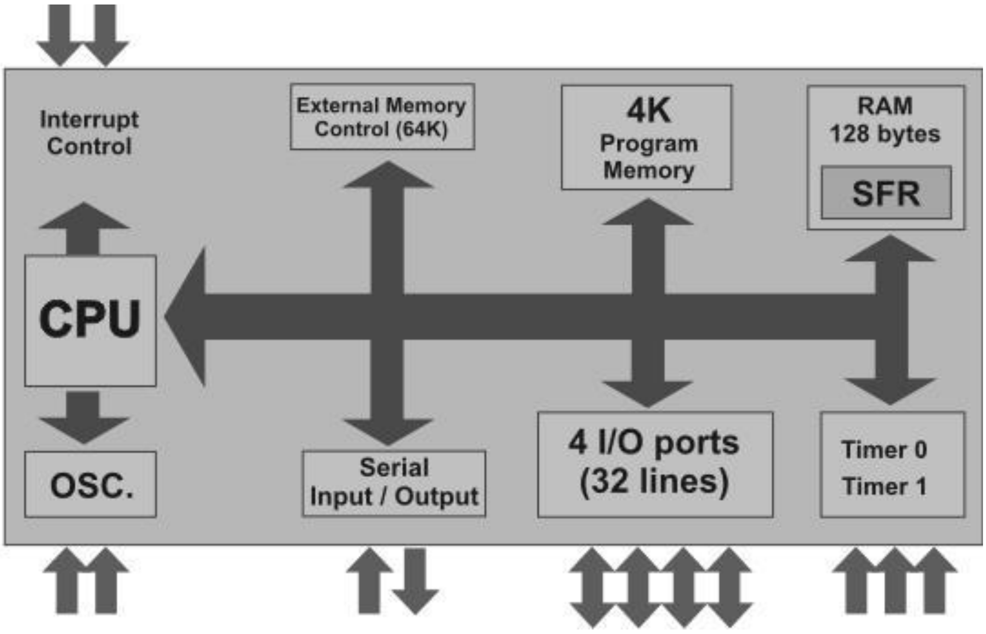
1. Don't come late to the Lab.
2. Don't leave the Lab without making proper shut down of desktop and keeping the chairs properly.
3. Don't leave the Lab without verification by Lab instructor.
4. Don't leave the lab without the permission of the Lecturer In-Charge.

1. STUDY OF 8051 MICROCONTROLLER TRAINER KIT

Aim

To study the 8051 microcontroller trainer kit

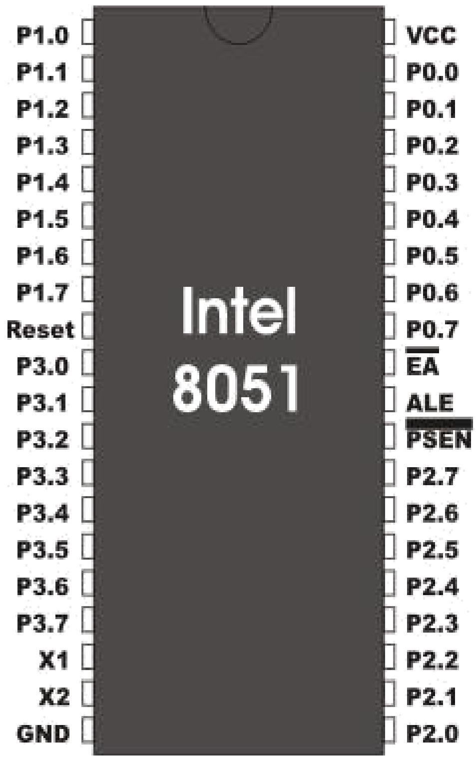
Architecture of 8051 Microcontroller



Architecture of 8051 microcontroller has following features

- 4 Kb of ROM is not much at all.
- 128Kb of RAM (including SFRs) satisfies the user's basic needs.
- 4 ports having in total of 32 input/output lines are in most cases sufficient to make all necessary connections to peripheral environment.

The whole configuration is obviously thought of as to satisfy the needs of most programmers working on development of automation devices. One of its advantages is that nothing is missing and nothing is too much. In other words, it is created exactly in accordance to the average user‘s taste and needs. Other advantages are RAM organization, the operation of Central Processor Unit (CPU) and ports which completely use all recourses and enable further upgrade.



Pin out Description

Pins 1-8: Port 1each of these pins can be configured as an input or an output.

Pin 9: RSA logic one on this pin disables the microcontroller and clears the contents of most registers. In other words, the positive voltage on this pin resets the microcontroller. By applying logic zero to this pin, the program starts execution from the beginning.

Pins10-17: Port 3Similar to port 1, each of these pins can serve as general input or output. Besides, all of them have alternative functions:

Pin 10: RXD Serial asynchronous communication input or Serial synchronous communication output.

Pin 11: TXD Serial asynchronous communication output or Serial synchronous communication clock output.

Pin 12: INT0Interrupt 0 inputs.

Pin 13: INT1Interrupt 1 input.

Pin 14: T0Counter 0 clock input.

Pin 15: T1Counter 1 clock input.

Pin 16: WR Write to external (additional) RAM.

Pin 17: RD Read from external RAM.

Pin 18, 19: X2, X1Internal oscillator input and output. A quartz crystal which specifies operating frequency is usually connected to these pins. Instead of it, miniature ceramics resonators can also be used for frequency stability. Later versions of microcontrollers operate at a frequency of 0 Hz up to over 50 Hz.

Pin 20: GND Ground.

Pin 21-28: Port 2If there is no intention to use external memory then these port pins are configured as general inputs/outputs. In case external memory is used, the higher address byte, i.e. addresses A8-A15 will appear on this port. Even though memory with capacity of 64Kb is not used, which means that not all eight port bits are used for its addressing, the rest of them are not available as inputs/outputs.

Pin 29: PSEN If external ROM is used for storing program then a logic zero (0) appears on it every time the microcontroller reads a byte from memory.

Pin 30: ALE Prior to reading from external memory, the microcontroller puts the lower address byte (A0-A7) on P0 and activates the ALE output. After receiving signal from the ALE pin, the external register (usually 74HCT373 or 74HCT375 add-on chip) memorizes the state of P0 and uses it as a memory chip address. Immediately after that, the ALU pin is returned its previous logic state and P0 is now used as a Data Bus. As seen, port data multiplexing is performed by means of only one additional (and cheap) integrated circuit. In other words, this port is used for both data and address transmission.

Pin 31: EA By applying logic zero to this pin, P2 and P3 are used for data and address transmission with no regard to whether there is internal memory or not. It means that even there is a program written to the microcontroller, it will not be executed. Instead, the program written to external ROM will be executed. By applying logic one to the EA pin, the microcontroller will use both memories, first internal then external (if exists).

Pin 32-39: Port 0Similar to P2, if external memory is not used, these pins can be used as general inputs/outputs. Otherwise, P0 is configured as address output (A0-A7) when the ALE pin is driven high (1) or as data output (Data Bus) when the ALE pin is driven low (0).

Pin 40: VCC+5V power supply.

Input/Output Ports (I/O Ports)

All 8051 microcontrollers have 4 I/O ports each comprising 8 bits which can be configured as inputs or outputs. Accordingly, in total of 32 input/output pins enabling the microcontroller to be connected to peripheral devices are available for use.

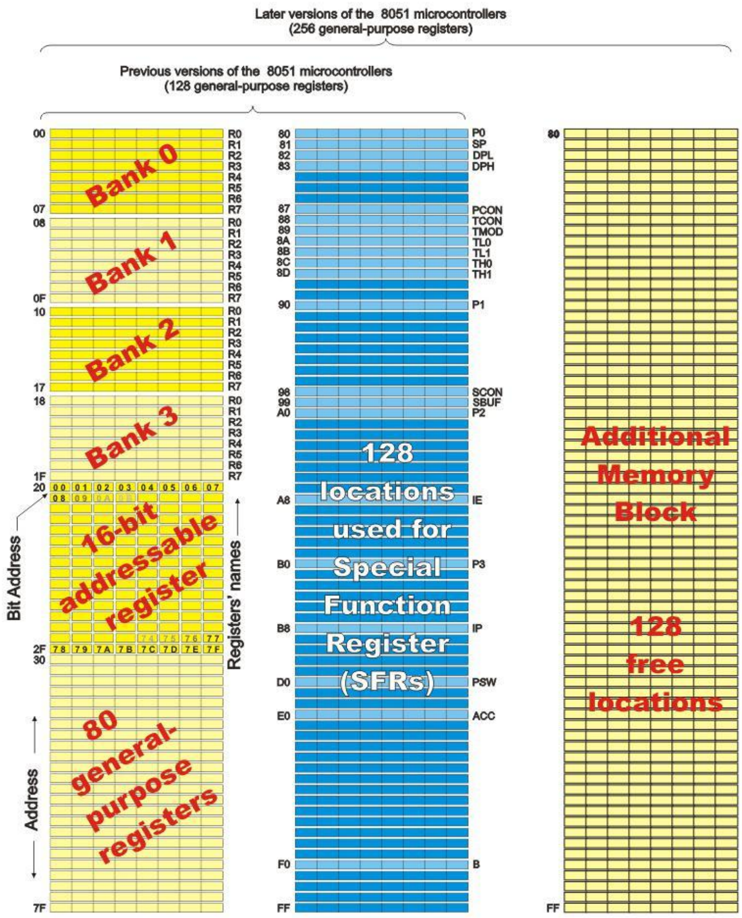
Pin configuration, i.e. whether it is to be configured as an input (1) or an output (0), depends on its logic state. In order to configure a microcontroller pin as an input, it is necessary to apply a logic zero (0) to appropriate I/O port bit. In this case, voltage level on appropriate pin will be 0.

Similarly, in order to configure a microcontroller pin as an input, it is necessary to apply a logic one (1) to appropriate port. In this case, voltage level on appropriate pin will be 5V (as is the case with any TTL input). This may seem confusing but don't loose your patience. It all becomes clear after studying simple electronic circuits connected to an I/O pin.

Memory Organization

The 8051 has two types of memory and these are Program Memory and Data Memory. Program Memory (ROM) is used to permanently save the program being executed, while Data Memory (RAM) is used for temporarily storing data and intermediate results created and used during the operation of the microcontroller. Depending on the model in use (we are still talking about the 8051 microcontroller family in general) at most a few Kb of ROM and 128 or 256 bytes of RAM is used.

All 8051 microcontrollers have a 16-bit addressing bus and are capable of addressing 64 kb memory. It is neither a mistake nor a big ambition of engineers who were working on basic core development. It is a matter of smart memory organization which makes these microcontrollers a real “programmers’ goody“.



Special Function Registers (SFRs)

Special Function Registers (SFRs) are a sort of control table used for running and monitoring the operation of the microcontroller. Each of these registers as well as each bit they include, has its name, address in the scope of RAM and precisely defined purpose such as timer control, interrupt control, serial communication control etc. Even though there are 128 memory locations intended to be occupied by them, the basic core, shared by all types of 8051 microcontrollers, has only 21 such registers. Rest of locations is intentionally left unoccupied in order to enable the manufacturers to further develop microcontrollers keeping them compatible with the previous versions. It also enables programs written a long time ago for microcontrollers which are out of production now to be used today.

F8									FF
F0	B								F7
E8									EF
E0	ACC								E7
D8									DF
D0	PSW								D7
C8									CF
C0									C7
B8	IP								BF
B0	P3								B7
A8	IE								AF
A0	P2								A7
98	SCON	SBUF							9F
90	P1								97
88	TCON	TMOD	TL0	TL1	TH0	TH1			8F
80	P0	SP	DPL	DPH				PCON	87

Bit-addressable Registers

Program Status Word (PSW) Register

	bit7	bit6	bit5	bit4	bit3	bit2	bit1	bit0	
	0	0	0	0	0	0	0	0	Value after Reset
PSW	CY	AC	F0	RS1	RS0	OV		P	Bit name

PSW register is one of the most important SFRs. It contains several status bits that reflect the current state of the CPU. Besides, this register contains Carry bit, Auxiliary Carry, two register bank select bits, Overflow flag, parity bit and user-definable status flag.

P - Parity bit. If a number stored in the accumulator is even then this bit will be automatically set (1), otherwise it will be cleared (0). It is mainly used during data transmit and receive via serial communication.

- **Bit 1.** This bit is intended to be used in the future versions of microcontrollers.

OV Overflow occurs when the result of an arithmetical operation is larger than 255 andcannot be stored in one register. Overflow condition causes the OV bit to be set (1). Otherwise, it will be cleared (0).

RS0, RS1 - Register bank select bits. These two bits are used to select one of four register banks of RAM. By setting and clearing these bits, registers R0-R7 are stored in one of four banks of RAM.

RS1	RS2	Space in RAM
0	0	Bank0 00h-07h
0	1	Bank1 08h-0Fh
1	0	Bank2 10h-17h
1	1	Bank3 18h-1Fh

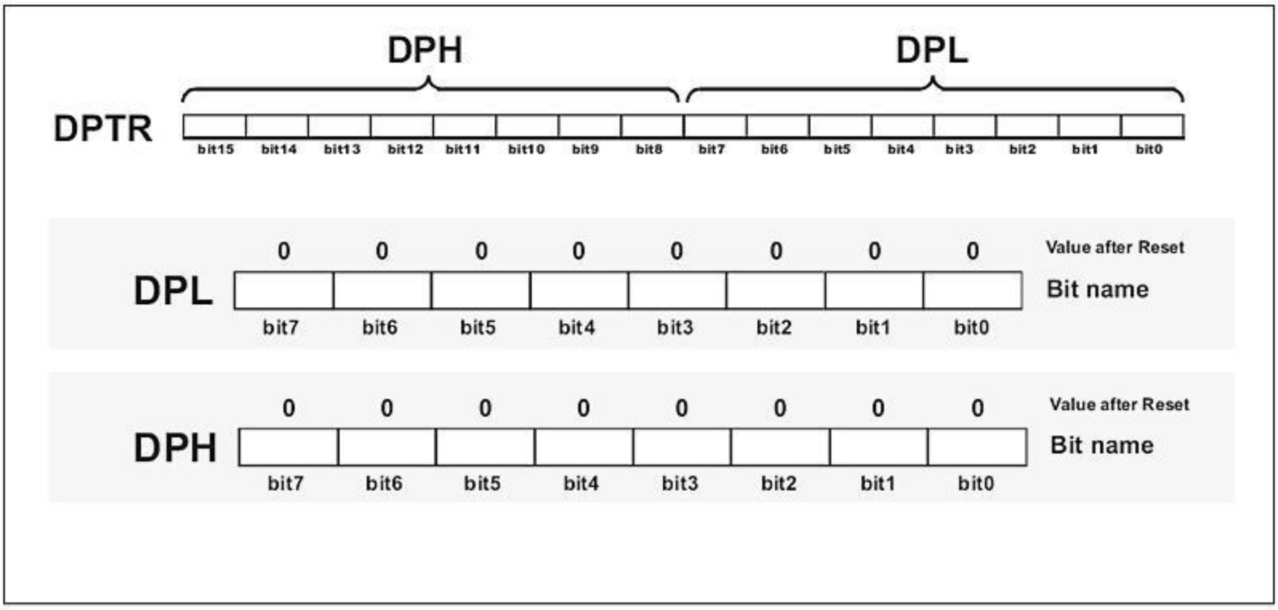
F0 - Flag 0. This is a general-purpose bit available for use.

AC - Auxiliary Carry Flag is used for BCD operations only.

CY - Carry Flag is the (ninth) auxiliary bit used for all arithmetical operations and shift instructions.

Data Pointer Register (DPTR)

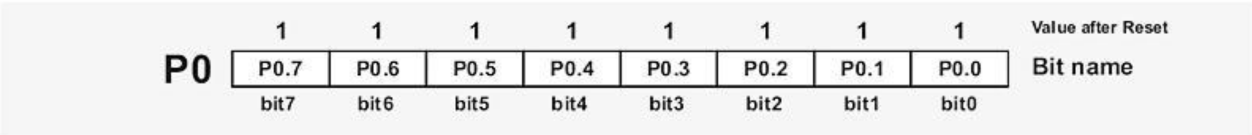
DPTR register is not a true one because it doesn't physically exist. It consists of two separate registers: DPH (Data Pointer High) and (Data Pointer Low). For this reason it may be treated as a 16-bit register or as two independent 8-bit registers. Their 16 bits are primarily used for external memory addressing. Besides, the DPTR Register is usually used for storing data and intermediate results.



Stack Pointer (SP) Register

A value stored in the Stack Pointer points to the first free stack address and permits stack availability. Stack pushes increment the value in the Stack Pointer by 1. Likewise, stack pops decrement its value by 1. Upon any reset and power-on, the value 7 is stored in the Stack Pointer, which means that the space of RAM reserved for the stack starts at this location. If another value is written to this register, the entire Stack is moved to the new memory location.

P0, P1, P2, P3 - Input/Output Registers



If neither external memory nor serial communication system are used then 4 ports within total of 32 input/output pins are available for connection to peripheral environment. Each bit within these ports affects the state and performance of appropriate pin of the microcontroller. Thus, bit logic state is reflected on appropriate pin as a voltage (0 or 5 V) and vice versa, voltage on a pin reflects the state of appropriate port bit.

As mentioned, port bit state affects performance of port pins, i.e. whether they will be configured as inputs or outputs. If a bit is cleared (0), the appropriate pin will be configured as an output, while if it is set (1), the appropriate pin will be configured as an input. Upon reset and power-on, all port bits are set (1), which means that all appropriate pins will be configured as inputs.

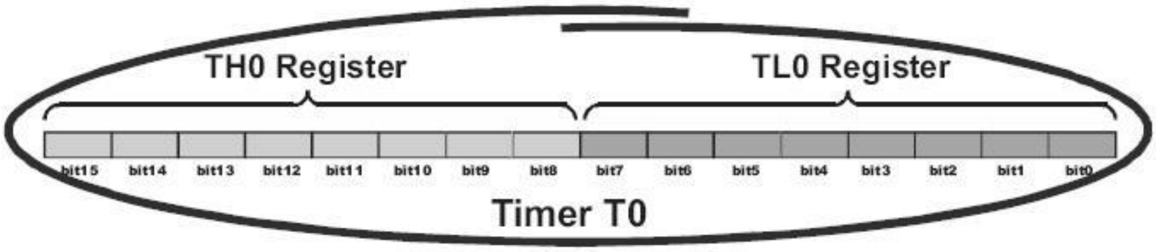
Counters and Timers

As you already know, the microcontroller oscillator uses quartz crystal for its operation. As the frequency of this oscillator is precisely defined and very stable, pulses it generates are always of the same width, which makes them ideal for time measurement. Such crystals are also used in quartz watches. In order to measure time between two events it is sufficient to count up pulses coming from this oscillator. That is exactly what the timer does. If the timer is properly programmed, the value stored in its register will be incremented (or decremented) with each coming pulse, i.e. once per each machine cycle. A single machine-cycle instruction lasts for 12 quartz oscillator periods, which means that by embedding quartz with oscillator frequency of 12MHz, a number stored in the timer register will be changed million times per second, i.e. each microsecond.

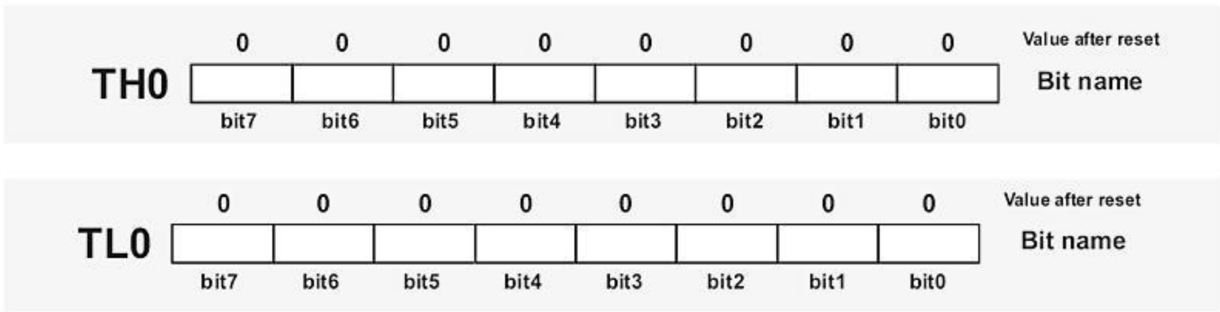
The 8051 microcontroller has 2 timers/counters called T0 and T1. As their names suggest, their main purpose is to measure time and count external events. Besides, they can be used for generating clock pulses to be used in serial communication, so called Baud Rate.

Timer T0

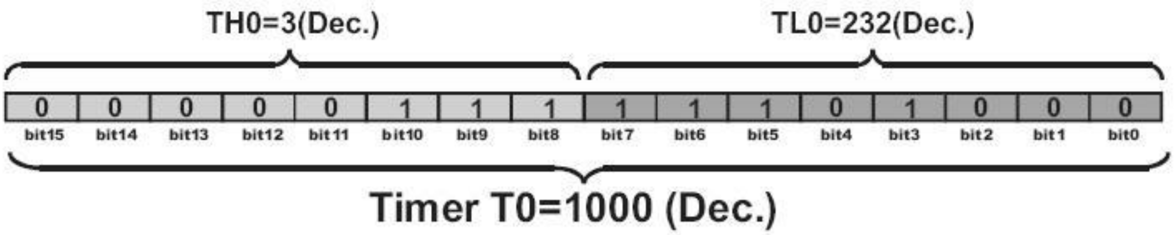
As seen in figure below, the timer T0 consists of two registers – TH0 and TL0 representing a low and a high byte of one 16-digit binary number.



Accordingly, if the content of the timer T0 is equal to 0 (T0=0) then both registers it consists of will contain 0. If the timer contains for example number 1000 (decimal), then the TH0 register (high byte) will contain the number 3, while the TL0 register (low byte) will contain decimal number 232.



Formula used to calculate values in these two registers is very simple:
TH0 × 256 + TL0 = T
Matching the previous example it would be as follows:
3 × 256 + 232 = 1000



Since the timer T0 is virtually 16-bit register, the largest value it can store is 65 535. In case of exceeding this value, the timer will be automatically cleared and counting starts from 0. This condition is called an overflow. Two registers TMOD and TCON are closely connected to this timer and control its operation.

TMOD Register (Timer Mode)

The TMOD register selects the operational mode of the timers T0 and T1. As seen in figure below, the low 4 bits (bit0 - bit3) refer to the timer 0, while the high 4 bits (bit4 - bit7) refer to the timer 1. There are 4 operational modes and each of them is described herein.

TMOD	bit7	bit6	bit5	bit4	bit3	bit2	bit1	bit0	
	0	0	0	0	0	0	0	0	Value after reset
	GATE1	C/T1	T1M1	T1M0	GATE0	C/T0	T0M1	T0M0	Bit name

Bits of this register have the following function:

- **GATE1** enables and disables Timer 1 by means of a signal brought to the INT1 pin (P3.3):
  - **1**- Timer 1 operates only if the INT1 bit is set.
  - **0**- Timer 1 operates regardless of the logic state of the INT1 bit.
- **C/T1** selects pulses to be counted up by the timer/counter 1:
  - **1** - Timer counts pulses brought to the T1 pin (P3.5).
  - **0**- Timer counts pulses from internal oscillator.
- **T1M1,T1M0** These two bits select the operational mode of the Timer 1.

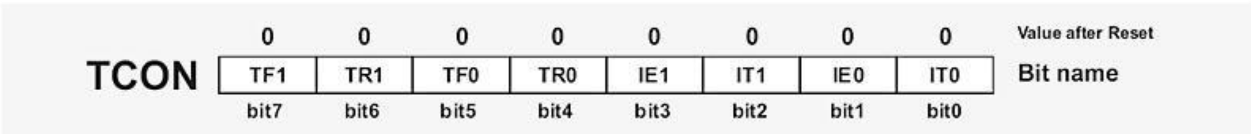
T1M1	T1M0	Mode	Description
0	0	0	13-bit timer
0	1	1	16-bit timer
1	0	2	8-bit auto-reload
1	1	3	Split mode

- **GATE0** enables and disables Timer 1 using a signal brought to the INT0 pin (P3.2):
  - **1**- Timer 0 operates only if the INT0 bit is set.
  - **0**- Timer 0 operates regardless of the logic state of the INT0 bit.
- **C/T0** selects pulses to be counted up by the timer/counter 0:
  - **1** - Timer counts pulses brought to the T0 pin (P3.4).
  - **0**- Timer counts pulses from internal oscillator.
- **T0M1,T0M0** These two bits select the oprtaional mode of the Timer 0.

T0M1	T0M0	Mode	Description
0	0	0	13-bit timer
0	1	1	16-bit timer
1	0	2	8-bit auto-reload
1	1	3	Split mode

Timer Control (TCON) Register

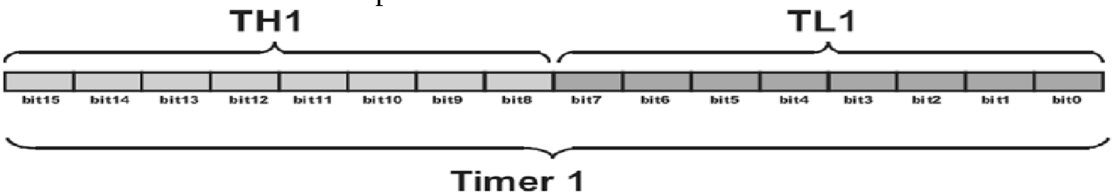
TCON register is also one of the registers whose bits are directly in control of timer operation.
Only 4 bits of this register are used for this purpose, while rest of them is used for interrupt control to be discussed later.

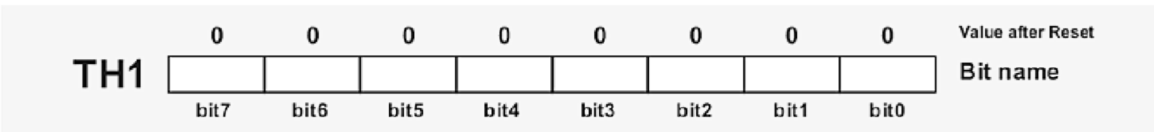


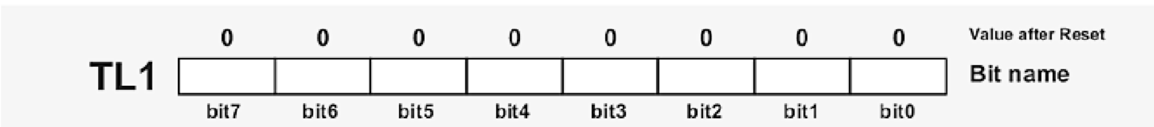
- **TF1** bit is automatically set on the Timer 1 overflow.
- **TR1** bit enables the Timer 1.
    - **1** - Timer 1 is enabled.
    - **0** - Timer 1 is disabled.
- **TF0** bit is automatically set on the Timer 0 overflow.
- **TR0** bit enables the timer 0.
    - **1** - Timer 0 is enabled.
    - **0** - Timer 0 is disabled.

Timer 1

Timer 1 is identical to timer 0, except for mode 3 which is a hold-count mode. It means that they have the same function, their operation is controlled by the same registers TMOD and TCON and both of them can operate in one out of 4 different modes.







Result:

Thus the 8051 Architecture has been studied.

Viva questions:

1) Compare and contrast the microprocessor and microcontroller.
2) How to change the register bank?
3) Name different Timer modes?
4) What is bit addressable ram and registers?
5) List the 16 bit registers.
6) What are the special registers in 8051 microcontroller?
7) Difference between timer and counter
8) How to switch between timer modes
9) How to change the baud rate?
10) What is the clock frequency?

2. ADDITION/SUBTRACTION OF 8-BIT NUMBERS USING 8051

Aim:

To do the addition/subtraction operations using 8051 microcontroller

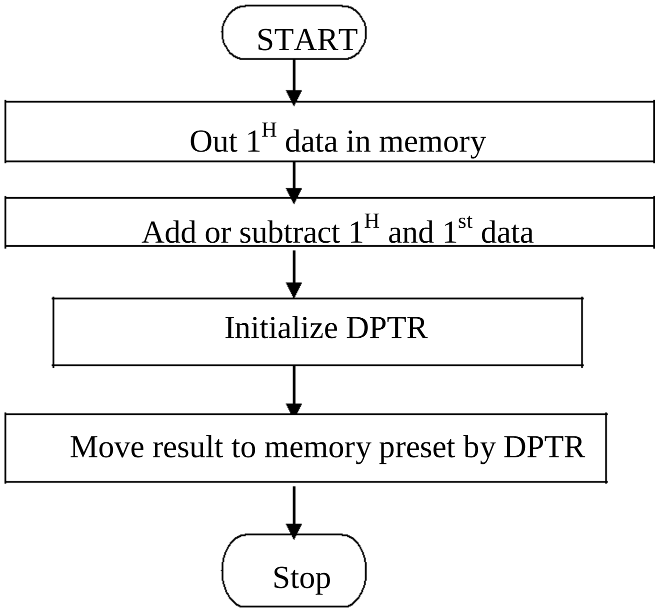
Apparatus required:

8051 microcontroller kit
DAC interface kit
Keyboard

Algorithm:

Addition / Subtraction

Step 1 : Move 1^{H} data to memory
Step 2 : Add or subtract 1^{H} data with 2^{nd} data
Step 3 : Initialize data pointer.
Step 4 : Move result to memory pointed by DPTR.



Program: 8-bit Addition:

Memory Location	Label	Opcode	Mnemonics	Comments
4100	Start	C3	CLR C	Clear the carry flat
4101		74DA	MOV A, #01	Moves data 1 to register A
4103		24DA	ADD A, #02	Add content of A and data 2 and store in A
4105		464500	MOV DPTR,#4500	Moves data 4500 to DPTR
4108		F0	MOVX @DPTR,A	Moves control of A to location pointed DTPR
4109		80 FE	SJMP 4109	Short jump to 4109

Execution:

Addition:

ML	Input
4103	
4109	

ML	Output
4500	

Program: 8-bit Subtraction:

Memory Location	Label	Opcode	Mnemonics	Comments
4100	Start	C3	CLR C	Clear the carry flat
4101		74DA	MOV A,#05	Moves data 1 to register A
4103		24DA	SUBB A,#02	Subtract data 2 from content of A and store result in A
4105		464500	MOV DPTR,#4500	Moves 4500 to DPTR
4108		F0	MOVX @DPTR,A	Moves result by location by DTPR
4109		80 FE	SJMP 4109	Short jump to 4109

Execution:

Subtraction:

ML	Input
4101	
4103	

ML	Output
4500	

Result:

Thus 8-bit addition/subtraction is performed using 8051.

Viva questions:

1) What are the arithmetic instructions?
2) How to perform higher byte arithmetic operations?
3) What are the flags involved in addition?
4) Explain multiplication and division
5) How to check the parity?
6) How to check the zero state?
7) Compare add and increment instruction.
8) How to perform signed arithmetic?
9) What is the role of psw in arithmetic operations?
10) How to check different conditions?

3. MULTIPLICATION/DIVISION OF 8-BIT NUMBERS USING 8051

Aim:

To do the multiplication/division operations using 8051 microcontroller

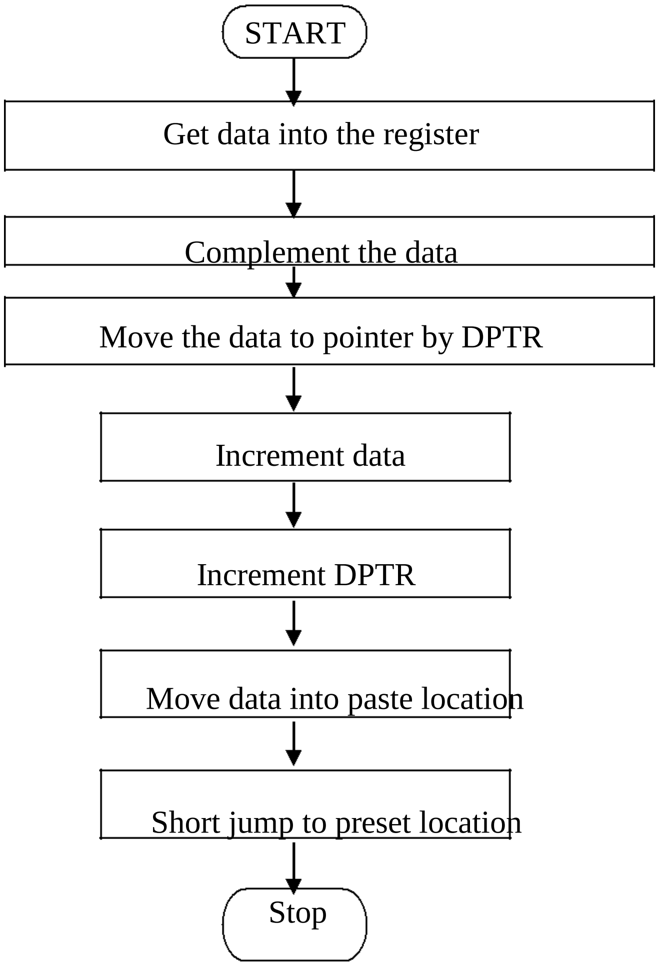
Apparatus required:

8051 microcontroller kit
DAC interface kit
Keyboard

Algorithm:

Multiplication / Division

Step 1	:	Get 1^{H} data and 2nd data to memory
Step 2	:	Multiply or divide 1^{H} data with 2nd data
Step 3	:	Initialize data pointer.
Step 4	:	Move result to memory pointed by DPTR (first port)
Step 5	:	Increment DPTR
Step 6	:	Move 2nd part of result to register A
Step 7	:	Move result to 2nd memory location pointer byDPTR



Program: 8-bit Multiplication:

Memory Location	Label	Opcode	Mnemonics	Comments
4100	Start	7403	MOV A,#03	Move immediate data to accumulator
4101		75F003	MOV B,#02	Move 2nd data to B register
4105		A4	MUL AB	Get the product in A & B
4106		904500	MOV DPTR, # 4500	Load data in 4500 location
4109 410A		F0	MOVX @DPTR,A INC DPTR	Move A t ext RAM
410B		E5F0	MOV A,B	Move 2nd data in A
410D		F0	MOVX @DPTR,A	Same the ext RAM
410E		80FE	SJMP 410E	Remain idle in infinite Loop

Execution:
Multiplication:

ML	Input
4101	
4103	

Output Address	Value
4500	

Program: 8-bit Division:

Memory Location	Label	Opcode	Mnemonics	Comments
4100	Start	7408	MOV A,#04	Move immediate data to accumulator
4102		75F002	MOV B,#02	Move immediate to B reg.
4105		84	DIV AB	Divide content of A & B
4106		904500	MOV DPTR, # 4500	Load data pointer with 4500 location
4109		F0	MOVX @DPTR,A	Move A to ext RAM
410A		A3	INC DPTR	Increment data pointer
410B		ESF0	MOV A,B	Move remainder to A
410D		F0	MOVX @DPTR,A	Move A to ext RAM
410E		80FE	SJMP 410E	Remain idle in infinite Loop

Execution:
Division:

ML	Input
4101	
4103	

Output Address	Value
4500	

Result:

Thus 8-bit multiplication and division is performed using 8051.

Viva questions:

1) What are the arithmetic instructions?
2) How to perform higher byte arithmetic operations?
3) What are the flags involved in addition?
4) Explain multiplication and division
5) How to check the parity?
6) How to check the zero state?
7) Compare add and increment instruction.
8) How to perform signed arithmetic?
9) What is the role of PSW in arithmetic operations?
10) How to check different conditions?

4. LARGEST ELEMENTS IN AN ARRAY

Aim:

Write an assembly language program to find the biggest number in an array of 8-bit unsigned numbers of predetermined length.

Apparatus required:

8051 Microcontroller kit
(0-5V) DC battery

Algorithm:

1. Initialize pointer and counter.
2. Load internal memory location 40H as zero.
3. Move the first element of an array to r5 register.
4. Compare the data stored in memory location 40H is equal to or less than the value of first element of an array.
5. If it is lesser, then move the data of first element to 40H memory location ELSE increment pointer and decrement counter.
6. Check the counter. If counter is not equal to zero, repeat from the 2nd step else Move the R5 register to 40H memory location.
7. Stop the program.

Program:

Memory Location	Label	Opcode	Mnemonics	Comments
4100		90 42 00	MOV DPTR,#4200H	
4103		75 40 00	MOV 40H,#00H	
4106		7D 0A	MOV R5,#0AH	
4108	LOOP2:	E0	MOVX A,@DPTR	
4109		B5 40 08	CJNE A,40H,LOOP1	
410C	LOOP 3	A3	INC DPTR	
410D		DD F9	DJNZ R5,LOOP2	
410F		E5 40	MOV A,40H	
4111		F0	MOVX @DPTR,A	
4112	HLT	80 FE	SJMP HLT	

4114	LOOP1	40 F6	JC LOOP3	
4116		F5 40	MOV 40H,A	
4118		80 F2	SJMP LOOP3	

SAMPLE INPUT AND OUTPUT:

INPUT:

Memory address	Data
4200	

OUTPUT:

Memory address	Data

Result:

Thus the assembly language program was written to find the largest element in an array and executed using 8051 microcontroller.

Viva questions:

1) How to access external memory?
2) How to access data memory?
3) How to store and access the array of numbers?
4) What is sorting?
5) Which flags get affected in sorting?
6) How to change the array order?

5. SORTING OF DATA-ASCENDING ORDER AND DESCEDING ORDER

AIM:

To arrange an array of 8-bit unsigned numbers of known length in an ascending order and descending order.

Apparatus required:

8051 microcontroller kit
(0-5V) DC battery

Algorithm:

1. Initialize the register and data pointer.
2. Get first two elements in registers A &B.
3. Compare the two elements of data. If value of B register is high then exchange A & B data else increment pointer and decrement register R3.
4. Check R3 is zero, and then move the register R5 & R6.
5. Again increment pointer and decrement R4,
6. Check R4 is zero. If no repeat the process from step 2.
7. Otherwise stop the program.

Program:

Memory Location	Label	Opcode	Mnemonics	Comments
4100		7B 04	MOV R3,#4	
4102		7C 04	MOV R4,#4	
4104		90 45 00	MOV DPTR,#4500	
4107	REPT 1:	AD 82	MOV R5,DPL	
4109		AE 83	MOV R6, DPH	
410B		E0	MOVX A,@DPTR	
410C		F5 FO	MOV B,A	
410E	REPT	A3	INC DPTR	
410F		E0	MOVX A,@DPTR	
4110		F8	MOV R0,A	
4111		C3	CLR C	
4112		95 F0	SUBB A,B	
4114		50 13	JNC CHKNXT	
4116	EXCH	C0 82	PUSH DPL	

4118		C0 83	PUSH DPH	
411A		8D 83	MOV DPL,R5	
411C		8E 83	MOV DPH,R6	
411E		E8	MOV A,R0	
411F		F0	MOVX @DPTR,A	
4120		D0 83	POP DPH	
4122		D0 82	POP DPL	
4124		E5 F0	MOV A,B	
4126		F0	MOVX @DPTR,A	
4127		88 F0	MOV B,R0	
4129	CHKNXT:	DBE3	DJNZ R3,REPT	
412B		1C	DEC R4	
412C		EC	MOV A,R4	
412D		FB	MOV R3,A	
412E		OC	INC R 4	
412F		8D 82	MOV DPL,R5	
4131		8E 83	MOV DPH,R6	
4133		A3	INC DPTR	
4134		DC D1	DJNZ R4,REPT1	
4136		80 FE	SJMP HLT	

Algorithm:

1. Initialize the register and data pointer.
2. Get first two elements in registers A &B.
3. Compare the two elements of data. If value of B register is low then exchange A & B data else increment pointer and decrement register R3.
4. Check R3 is zero, and then move the register R5 & R6.
5. Again increment pointer and decrement R4,
6. Check R4 is zero. If no repeat the process from step 2.
7. Otherwise stop the program.

Program for Descending:

Memory Location	Label	Opcode	Mnemonics	Comments
4100		7B 04	MOV R3,#4	
4102		7C 04	MOV R4,#4	
4104		90 45 00	MOV DPTR,#4500	
4107	REPT 1:	AD 82	MOV R5,DPL	
4109		AE 83	MOV R6, DPH	
410B		E0	MOVX A,@DPTR	
410C		F5 FO	MOV B,A	
410E	REPT	A3	INC DPTR	
410F		E0	MOVX A,@DPTR	
4110		F8	MOV R0,A	
4111		C3	CLR C	
4112		95 F0	SUBB A,B	
4114		50 13	JC CHKNXT	
4116	EXCH	C0 82	PUSH DPL	
4118		C0 83	PUSH DPH	
411A		8D 83	MOV DPL,R5	
411C		8E 83	MOV DPH,R6	
411E		E8	MOV A,R0	
411F		F0	MOVX @DPTR,A	
4120		D0 83	POP DPH	
4122		D0 82	POP DPL	
4124		E5 F0	MOV A,B	

4126		F0	MOVX @DPTR,A	
4127		88 F0	MOV B,R0	
4129	CHKNXT:	DBE3	DJNZ R3,REPT	
412B		1C	DEC R4	
412C		EC	MOV A,R4	
412D		FB	MOV R3,A	
412E		OC	INC R 4	
412F		8D 82	MOV DPL,R5	
4131		8E 83	MOV DPH,R6	
4133		A3	INC DPTR	
4134		DC D1	DJNZ R4,REPT1	
4136		80 FE	SJMP HLT	

SAMPLE INPUT AND OUTPUT ASCENDING

INPUT:

Memory address	Data

OUTPUT:

Memory address	Data

SAMPLE INPUT AND OUTPUT

DESCENDING INPUT:

Memory address	Data

OUTPUT:

Memory address	Data

Result:

Thus the assembly language program was written to sort the data in an ascending/descending order and executed using 8051 microcontroller.

Viva questions:

1) How to access external memory?
2) How to access data memory?
3) How to store and access the array of numbers?
4) What is sorting?
5) Which flags get affected in sorting?
6) How to change the array order?

6. SPEED CONTROL OF STEPPER MOTOR

Aim:

To write an assembly program to make the stepper motor run in forward and reverse direction.

Apparatus required:

Stepper motor
8051 microcontroller kit
(0-5V) power supply

Algorithm:

1. Fix the DPTR with the Latch Chip address FFC0
2. Move the values of register A one by one with some delay based on the 2-Phase switching Scheme and repeat the loop.
3. For Anti Clockwise direction repeat the step 3 by reversing the value sequence.
4. End the Program

Memory Location	Label	Opcode	Mnemonics	Comments
4100		90 FF C0	MOV DPTR, #FFC0	
4103		74 09	MOV A, #09	
4105		E0	MOVX @DPTR, A	
4106		12 41 3B	LCALL DELAY	
4109		74 05	MOV A, #05	
410B		E0	MOVX @DPTR, A	
410C		12 41 3B	LCALL DELAY	
410F		74 06	MOV A, #06	
411B		E0	MOVX @DPTR, A	
411C		12 41 3B	LCALL DELAY	
411F		74 0A	MOV A, #0A	
412B		E0	MOVX @DPTR, A	
412C		12 41 3B	LCALL DELAY	

412F			SJMP 412F	
413B	DELAY			
413B	L2		MOV R0, #55	
413D	L1		MOV R1, #FF	
413F			DJNZ R1, L1	
413B			DJNZ R0, L2	
413D			RET	

Result:

Thus an assembly language program to control of stepper motor was executed successfully using 8051 Microcontroller kit.

Viva questions:

1. What is the principle on which electromagnetic relays operate?
2. What are DPDT relays?
3. Why do we need a ULN2803 in driving a relay?
4. Why are solid-state relays advantageous over electromechanical relays?
5. What are optoisolators?
6. How can we control the speed of a stepper motor?
7. The RPM rating given for the DC motor is for?
8. How can we change the speed of a DC motor using PWM?
9. How can the direction of the stepper motor be changed?

7. Eight-Bit Analog to Digital Converter

Aim:

To write an assembly language program for analog to digital converter.

Apparatus required:

8051 microcontroller kit

(0-5V) DC battery

Algorithm:

1. Make ALE low/high by moving the respective data from A register to DPTR.
2. Move the SOC(Start Of Conversion) data to DPTR from FFD0
3. Check for the End Of Conversion and read data from Buffer at address FFC0
4. End the Program.

PROGRAM:

Port Address for 74LS174 Latch: FFC8
Port Address for SOC: FFD0
Port Address for EOC 1: FFD8
Port Address for 74LS 244 Buffer: FFC0

Memory Location	Label	Opcode	Mnemonics	Comments
4100		90 FF C8	MOV DPTR, #FFC8	
4103		74 10	MOV A, #10	Select Channel 0
4105		F0	MOVX @DPTR, A	Make ALE Low
4106		74 18	MOV A, #18	Make ALE High
4108		F0	MOVX @DPTR, A	
4109		90 FF D0	MOV DPTR, #FFD0	
410C		74 01	MOV A, #01	SOC Signal High
410E		F0	MOVX @DPTR, A	
410F		74 00	MOV A, #00	SOC Signal Low
4111		F0	MOVX @DPTR, A	
4112		90 FF D8	MOV DPTR, #FFD8	
4115		E0	MOVX A, @DPTR	
4116		30 E0 FC	JNB E0, WAIT	Check For EOC
4119		90 FF C0	MOV DPTR, #FFC0	Read ADC Data
411C		E0	MOVX A, @DPTR	
4110		90 41 50	MOV DPTR, #4150	Store the Data
4120		F0	MOVX @DPTR, A	
4121		90 FE	SJMP HERE	

Result:

Thus an assembly language program is executed for analog to digital conversion.

Viva questions:

1. Why MOVX instruction is being used to access the ports of the 8255?
2. How many pins of the 8255 can be used as the I/O ports?
3. Why two pins for ground are available in ADC0804?
4. What is the function of the WR pin?
5. While programming the ADC0808/0809 IC what steps are followed?
6. In ADC0808/0809 IC which pin is used to select Step Size?

8. Eight-Bit Digital to Analog Converter

Aim:

To write an assembly language program for digital to analog converter.

Apparatus required:

8051 microcontroller kit

(0-5V) DC battery

Algorithm:

1. Move the Port Address of DAC 2 FFC8 to the DPTR.
2. Move the Value of Register A to DPTR and then Call the delay.
3. Move the Value of Register A (FFh) to DPTR and the call the dalay.
4. Repeat the steps 2 and 3.

PROGRAM TO GENERATE SQUARE WAVEFORM

Memory Location	Label	Opcode	Mnemonics	Comments
4100		90 FF C8	MOV DPTR, #0FFC8H	
4103	START:	74 00	MOV A, #00H	
4105		F0	MOVX @DPTR, A	
4106		12 41 12	LCALL DELAY	
4109		74 FF	MOV A, #0FFH	
410B		F0	MOVX @DPTR, A	
410C		12 41 12	LCALL DELAY	
410F		02 41 03	LJMP STTART	
4112		79 05	MOV R1, #05H	
4114		7A FF	MOV R2, #0FFH	
4116		DA FE	DJNZ R2, HERE	
4118		D9 FA	DJNZ R1, LOOP	
411A		22	RET	
411B		80 E6	SJMP START	

PROGRAM TO GENERATE SAW-TOOTH WAVEFORM

Memory Location	Label	Opcode	Mnemonics	Comments
4100		90 FF C0	MOV DPTR, #0FFC0H	
4103		74 00	MOV A, #00H	
4105		F0	MOVX @DPTR, A	
4106		04	INC A	
4107		80 FC	SJMP LOOP	

PROGRAM TO GENERATE TRIANGULAR WAVEFORM

Memory Location	Label	Opcode	Mnemonics	Comments
4100		90 FF C8	MOV DPTR, #0FFC8H	
4103		74 00	MOV A, #00H	
4105		F0	MOVX @DPTR, A	
4106		04	INC A	
4107		70 FC	JNZ LOOP1	
4109		74 FF	MOV A, #0FFH	
411B		F0	MOVX @DPTR, A	
410C		14	DEC A	
410D		70 FC	JNZ LOOP2	
410F		02 41 03	LJMP START	

Result:

Thus an assembly language program for Digital to Analog has been executed.

Viva questions:

1. Why the switches used in weighted resistor DAC are of single pole double throw (SPDT) type?
2. Determine the Full scale output in a 8-bit DAC for 0-15v range?
3. How to decide the digital levels?
4. Which pins of a microcontroller are directly connected with 8255?

9. Transfer data serially between two kits

Aim:

To write an assembly language program Transmitting and Receiving the data between two kits.

Apparatus required:

8051 microcontroller kit

(0-5V) DC battery

Algorithm:

1. Initialize TMOD with 20H
2. Set the values for TCON and SCON
3. Set the input address to DPTR
4. Based on the bit value on SCON store the data in SBUF
5. Increment DPTR and check for the loop end value

PROGRAM FOR RECEIVER.

Memory Location	Label	Opcode	Mnemonics	Comments
4100		75 89 20	MOV TMOD, #20H	
4103		75 8D A0	MOV TH1, #0A0H	
4106		75 8B 00	MOV TL1, #00H	
4109		75 88 40	MOV TCON, #40H	
410C		75 98 58	MOV SCON, #58H	
410F		90 45 00	MOV DPTR, #4500H	
4112	RELOAD	7D 05	MOV R5, #05H	
4114	CHECK	30 98 FD	JNB SCON.0, CHECK	
4117		C2 98	CLR SCON.0	
4119		E5 99	MOV A, SBUF	
411B		F0	MOVX @DPTR, A	
411C		A3	INC DPTR	
411D		B4 3F F2	CJNE A, #3FH, RELOAD	
4120		DD F2	DJNZ R5, CHECK	
4122		E4	CLAR A	
4123		12 00 20	LCALL 0020H	

Algorithm for Transmitter:

1. Initialize TMOD with 20H
2. Set the values for TCON and SCON
3. Set the input address to DPTR
4. Based on the bit value on SCON store the data in SBUF and move the data to register ‘A’.
5. Increment DPTR and check for the loop end value

PROGRAM FOR TRANSMITTER.

Memory Location	Label	Opcode	Mnemonics	Comments
4100		75 89 20	MOV TMOD, #20H	
4103		75 8D A0	MOV TH1, #0A0H	
4106		75 8B 00	MOV TL1, #00H	
4109		75 88 40	MOV TCON, #40H	
410C		75 98 58	MOV SCON, #58H	
410F		90 45 00	MOV DPTR, #4500H	
4112	RELOAD	7D 05	MOV R5, #05H	
4114	REPEAT	E0	MOVX A, @DPTR	
4115		F5 99	MOV SBUF, A	
4117	CHECK	30 99 FD	JNB SCON.1, CHECK	
411A		C2 99	CLR SCON.1	
411C		A3	INC DPTR	
411D		B4 3F F2	CJNE A, #3FH, RELOAD	
4120		DD F2	DJNZ R5, REPEAT	
4122		E4	CLAR A	
4123		12 00 20	LCALL 0020H	

SAMPLE INPUT AND OUTPUT:

Sl.No	Transmitter Input (Hex Values)	Receiver Output (Hex Values)
1	00	00
2	11	11
3	22	22
4	33	33

Result:

Thus an assembly language program for transmitting and Receiving the data between two kits

Viva questions:

1. Which devices are specifically being used for converting serial to parallel and from parallel to serial respectively?
2. What is the difference between UART and USART communication?
3. What is the function of the SCON register?
4. What should be done if we want to double the baud rate?
5. Why baud rate is mentioned in serial communication?
6. What is a null modem connection?
7. Which logic level is understood by the micro-controller/micro-processor?
8. Which signal controls the flow of data?

10.8051 MICROCONTROLLER TIMER/COUNTER PROGRAMMING

AIM:
Generate a Square wave form with an ON time of 3 ms and an OFF time of 10 ms an all pins of port 0. Assume XTAL of 22 MHz (Use assembly language in Keil software).

SOFTWARE REQUIRED:

Keil IDE

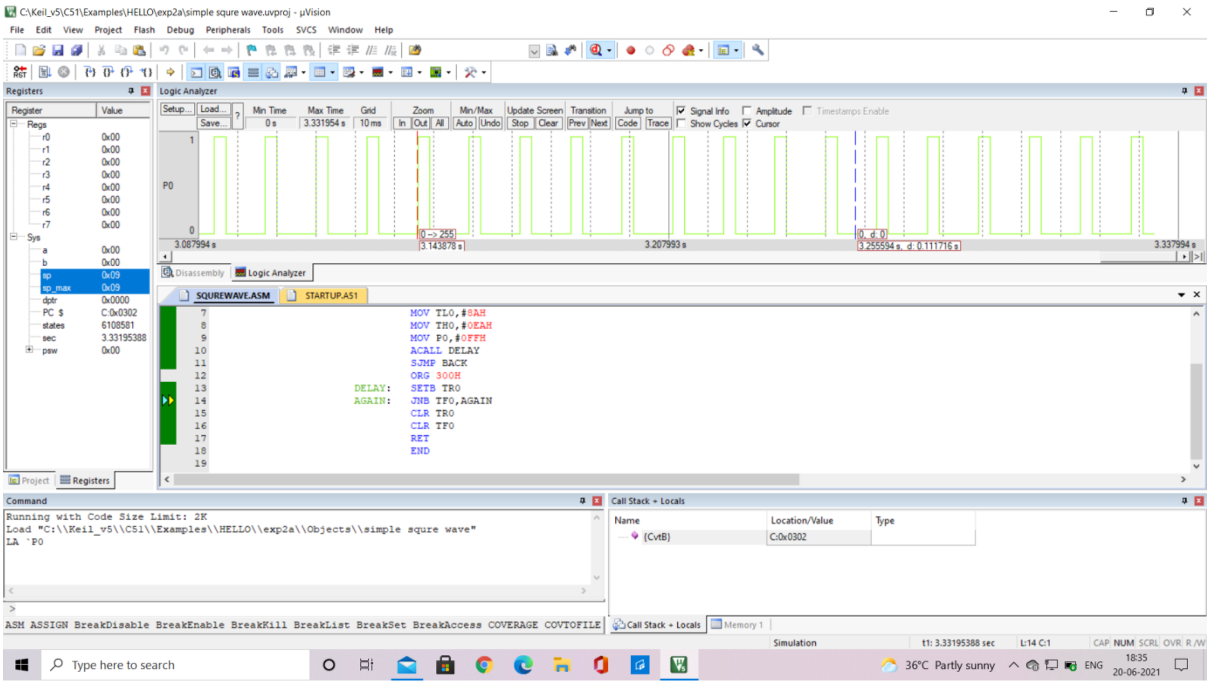
PROCEDURE:

- Click KeilµVision2 icon in the desktop
- From Project Menu open New project
- Select the target device as AT89C51
- From File Menu open New File
- Type the program in Text Editor
- Save the file with extension".asm" for ALP and ".C" extension for embedded C program.
- In project window click the tree showing TARGET
- A source group will open.
- Right Click the Source group and click"Add files to Source group"
- A new window will open. Select our file with extension".asm"
- Click Add.
- Go to project window and right click Source group again
- Click Build Target(F7).
- Errors if any will be displayed.
- From Debug menu,select START/STOP Debug option.
- In project window the status of all the registers will be displayed.
- Click Go from Debug Menu.
- The results stored in registers will be displayed in Project window.
- Stop the Debug process before closing the application.

PROGRAM:
```
         ORG 0000H
         MOV TMOD,#01H
BACK:    MOV TL0,#75H
         MOV TH0,#0B8H
         MOV P0,#00
         ACALL DELAY
         MOV TL0,#08AH
         MOV TH0,#0EAH
         MOV P0,#0FFH
         ACALL DELAY
         SJMP BACK
         ORG 300H
DELAY:   SETB TR0
```

```
AGAIN:      JNB TF0,AGAIN
            CLR TR0
            CLR TF0
            RET
            END
```

SIMULATION RESULT



Result:
A Square wave form with an ON time of 3 ms and an OFF time of 10 ms is generated and verified using Keil software.

Viva questions:
1) What is timer/counter registers in 8051?
2) What is the size of timer/Counter?
3) When timer overflow occurs?

11. TRAFFIC LIGHT CONTROLLER

Aim:

To write an assembly language program to display Characters on a seven display interface.

Apparatus required:

8051 microcontroller kit

(0-5V) DC battery

Algorithm:

1. Fix the control the control and move the control word to control register.
2. Move the Traffic Light LED Position values to Port A, Port B and Port C respectively based on the logic.
3. Fix the delay based on the requirement.
3. Execute the program.

PROGRAM:

4100		ORG	4100
	CONTRL	EQU	0FF0FH
	PORT A	EQU	0FF0CH
	PORT B	EQU	0FF0DH
	PORT C	EQU	0FF0EH

Memory Location	Label	Opcode	Mnemonics	Comments
4100		74 80	MOV A, #80H	
4102		90 FF 0F	MOV DPTR, #CONTRL	
4105		F0	MOVX @DPTR, A	
4106	START	7C 04	MOV R4, #04H	
4108		90 41 9B	MOV DPTR, #LOOK1	
410B		AA 83	MOV R2, DPH	
410D		AB 82	MOV R3, DPL	
410F		90 41 8F	MOV DPTR, #LOOK	
4112		A8 83	MOV R0, DPH	
4114		A9 82	MOV R1, DPL	
4116	GO	E0	MOVX A, @DPTR	
4117		A8 83	MOV R0, DPH	
4119		A9 82	MOV R1, DPL	
411B		90 FF 0C	MOV DPTR, #PORT A	
411E		F0	MOVX @DPTR, A	
411F		09	INC R1	
4120		88 83	MOV DPH, R0	
4122		89 82	MOV DPL, R1	
4124		E0	MOVX A, @DPTR	
4125		A8 83	MOV R0, DPH	
4127		A9 82	MOV R1, DPL	

4129		90 FF 0D	MOV DPTR, #PORT B	
412C		F0	MOVX @DPTR, A	
412D		09	INC R1	
412E		88 83	MOV DPH, R0	
4130		89 82	MOV DPL, R1	
4132		E0	MOVX A, @DPTR	
4133		A8 83	MOV R0, DPH	
4135		A9 82	MOV R1, DPL	
4137		90 FF 0E	MOV DPTR, #PORT C	
413A		F0	MOVX @DPTR, A	
413B		09	INC R1	
413C		12 41 75	LCALL DELAY	
413F		8A 83	MOV DPH, R2	
4141		8B 82	MOV DPL, R3	
4143		E0	MOVX A, @DPTR	
4144		AA 83	MOV R2, DPH	
4146		AB 82	MOV R3, DPL	
4148		90 FF 0C	MOV DPTR, #PORT A	
414B		F0	MOVX @DPTR, A	
414C		0B	INC R3	
414D		8A 83	MOV DPH, R2	
414F		8B 82	MOV DPL, R3	
4151		E0	MOVX A, @DPTR	
4152		AA 83	MOV R2, DPH	
4154		AB 82	MOV R3, DPL	
4156		90 FF 0D	MOV DPTR, #PORT B	
4159		F0	MOVX @DPTR, A	
415A		0B	INC R3	
415B		8A 83	MOV DPH, R2	
415D		8B 82	MOV DPL, R3	
415F		E0	MOVX A, @DPTR	
4160		AA 83	MOV R2, DPH	
4162		AB 82	MOV R3, DPL	
4164		90 FF 0E	MOV DPTR, #PORT C	
4167		F0	MOVX @DPTR, A	
4168		0B	INC R3	
4169		12 41 82	LCALL DELAY1	
416C		88 83	MOV DPH, R0	
416E		89 82	MOV DPL, R1	
4170		DC A4	DJNZ R4, GO	
4172		12 41 06	LCALL START	
4175	DELAY	7D 12	MOV R5, #12H	
4177	L3	7E FF	MOV R6, #0FFH	
4179	L2	7F FF	MOV R7, #0FFH	
417B	L1	DF FE	DJNZ R7, L1	
417D		DE FA	DJNZ R6, L2	
417F		DD F6	DJNZ R5, L3	
4181		22	RET	
4182	DELAY1	7D 12	MOV R5, #12H	

4184	L6	7E FF	MOV R6, #0FFH	
4186	L5	7F FF	MOV R7, #0FFH	
4188	L4	DF FE	DJNZ R7, L4	
418A		DE FA	DJNZ R6, L5	
418C		DD F6	DJNZ R5, L6	
418E		22	RET	
418F	LOOK	44 27 12	DB 44H, 27H, 12H	
4192		92 2B 10	DB 92H, 2BH, 10H	
4195		84 9D 10	DB 84H, 9DH, 10H	
4198		84 2E 48	DB 84H, 2EH, 48H	
419B	LOOK1	48 27 12	DB 48H, 27H, 12H	
419E		92 4B 10	DB 92H, 4BH, 10H	
41A1		84 9D 20	DB 84H, 9DH, 20H	
41A4		04 2E 49	DB 04H, 2EH, 49H	

Result:

Thus an assembly language program for the Traffic Light Control has been executed.

Viva questions:

1. Which pins of a microcontroller are directly connected with 8255?
2. Which pins are used to select the ports and the control register?
3. How many pins of the 8255 can be used as the I/O ports?
4. How to move the position?
5. How to delay the signaling?
6. How to incorporate realtime traffic monitoring?
7. How to do demand based signaling?
8. How to sense the traffic density?

12. TEST PROGRAM USING ARM 9 mini 2440 KIT

Aim:

To write a test program for interfacing LED with ARM9 mini 2440 kit

Apparatus required:

ARM 9 mini 2440 kit

(0-5V) DC battery

Procedure:

1. When developing C language programs, the main function is generally used as the entry point, and the main function is just a function, so it must be called by others and the return value is returned to the caller. So when we are developing, when the LED is on, no one will call our function, so we need to do this work by ourselves.
2. Hardware initialization: turn off the watchdog
3. Software initialization: set the stack: point the stack pointer sp to a certain piece of memory
4. The initialization of hardware and software is called a startup file, and the startup file is an assembly code

PROGRAM:

Startup file crt0.S

```
.text
.global _start
_start:
        LDR r0,=0x53000000 @WATCHDOG register address
         MOV r1, #0x00000000 @r1 is 0
         STR r1,[r0] @Write 0, disable WATCHDOG, otherwise the CPU will restart continuously
         LDR sp,=1024*4 @Set the stack, note: it cannot be larger than 4k, because the available memory is
only 4k
                                                @ Memory SRAM, 4k
 The code in @Nand Flash will be moved to the internal ram after reset, this ram is only 4k
         bl main @call the main function in the c program, the bl instruction will jump to the main function,
and put the return value in lr
halt_loop:
        b        halt_loop
```

ledon_c.c file

```
#define GPBCON  *((volatile unsigned long *)0x56000010)
#define GPBDAT       *((volatile unsigned long *)0x56000014)
 //volatile is to let the compiler not to optimize

int main()
{
         GPBCON = 0x00000400;//Set GPB5 as the output port
        GPBDAT = 0x00000000;
```

```
        return 0;

}
```

Makefile

```
CFLAGS     := -Wall -Wstrict-prototypes -O2 -fomit-frame-pointer -ffreestanding
ledon.bin:crt0.S ledon_c.c
   arm-linux-gcc -g -c crt0.S -o crt0.o
   arm-linux-gcc -g -c ledon_c.c  -o ledon_c.o
   arm-linux-ld  -Ttext  0x00000000  crt0.o ledon_c.o  -o ledon_elf
   arm-linux-objcopy -O binary  -S ledon_elf ledon.bin
   arm-linux-objdump -D -m arm  ledon_elf > ledon.dis
clean:
   rm -rf  *.bin *elf *.o *.dis
```

Result:

Thus an assembly language program for interfacing LED with ARM9 mini 2440 kit has been done.

Viva questions:

1. What is the oscillator frequency of mini 2440 kit?
2. How many jumpers are available in mini 2440 kit?
3. How ARM 9 is different from 8085 and 8086 processors?

13. Hex TO ASCII CONVERSION

Aim:

Write an assembly language program to convert a binary number to its equivalent ASCII code and display the result in the address field.

Apparatus required:

8051 microcontroller kit
(0-5V) DC battery

Algorithm:

1. Get the decimal number in the range 00 to 99 as input
2. Separate the higher and lower nibble of the two digit number
3. Add 30h to the lower nibble and store the result
4. Bring the higher nibble to the ones position, add 30h to it and display the result.

Program:

Memory Location	Label	Opcode	Mnemonics	Comments
4100		90 42 00	MOV DPTR,#4200H	Input a Hex Value
4103		E0	MOVX A, @DPTR	
4104		F8	MOV R0,A	
4105		94 0A	SUBB A, #0AH	Compare Value 0-9
4107		50 05	JNC LOOP1	Values A-F go to Loop 1
4109		E8	MOV A,R0	
410A		24 30	ADD A,#30H	0-9 Add 30H
410C		80 03	SJMP LOOP	
410E	LOOP 1	E8	MOV A, RO	
410F		24 37	ADD A, #37H	A-F Add 37H
4111	LOOP	90 45 00	MOV DPTR, #4500H	
4114		F0	MOVX @DPTR, A	ASCII Value Output
4115		80 FE	SJMP 4115	

SAMPLE INPUT AND OUTPUT:

INPUT:

Memory address	Data
4200	Hex Data=

OUTPUT:

Memory address	Data
4500	ASCII Data=

Result:

Thus the assembly language program was written to converter Hexadecimal number to equivalent ASCII Code and executed using 8051 microcontroller.

Viva questions:

1) How hex is different from binary?
2) What is ASCII?
3) What is extended ASCII?
4) How many iterations needed in the convertion?
5) How many registers are involved?
6) What is the complexity involved?

14. ASCII TO BINARY CONVERSION

Aim:

Write an ALP to convert a ASCII to its equivalent BINARY number and display the result in the data field.

Apparatus required:

8051 microcontroller kit
(0-5V) power supply

Algorithm:

Step1: Get the Ascii code.
Step2: Clear carry bit
Step3: Subtract with borrow 30h from the input
Step4: Subtract Accumulator with 0AH
Step5: Display Hexadecimal Value at 4300H
Step6: Display Binary Value at 4500H

Program:

Memory Location	Label	Opcode	Mnemonics	Comments
4100		90 42 00	MOV DPTR#4200H	Get an Input
4103		E0	MOVX A,@DPTR	
4104		C3	CLR C	
4105		94 30	SUBB A,#30H	Convert ASCII
4107		C3	CLR C	
4108		94 0A	SUBB A, #0AH	
410A		40 04	JC LOOP	
410C		74 FF	MOV A, #FFH	
410E		80 02	SJMP L1	
4110	LOOP	24 0A	ADD A,#0AH	
4112	L1	90 43 00	MOV DPTR, #4300H	
4115		F0	MOVX @DPTR,A	
4116		F5 F0	MOV B,A	

4118		79 08	MOV R1,#08H	
411A		90 45 00	MOV DPTR,#4500H	BINARY OUTPUT
411D	LOP	13	RRC A	
411E		F5 F0	MOV B,A	
4120		40 05	JC LOOP1	
4122		74 00	MOV A,#00H	
4124		F0	MOVX @DPTR,A	
4125		80 03	SJMP RESULT	
4127	LOOP1	74 01	MOV A, #01H	
4129		F0	MOVX @DPTR, A	
412A	RESULT	05 82	INC DPL	
412C		E5 F0	MOV A,B	
412E		D9 ED	DJNZ R1, LOP	
4130		80 FE	SJMP 4130	

	Address	**Sample1**	**Sample2**
Input (ASCII)	4200		
Hexa Decimal Value	4300		
Output (BINARY)in the data field	4500		
	4501		

Result:

Thus the assembly language program was written to converter ASCII number to equivalent Binary Value and executed using 8051 microcontroller.

Viva questions:

1) How hex is different from binary?
2) What is ASCII?
3) What is extended ASCII?
4) How many iterations needed in the convertion?
5) How many registers are involved?
6) What is the complexity involved?

15. FIND THE SQUARE ROOT OF A GIVEN DATA

Aim:

To write an assembly language program to find the square root of a given data

Apparatus required:

8051 microcontroller kit

(0-5V) DC battery

Algorithm:

1. Enter a program.
2. Enter the input hex value to location 4200h.
3. Execute the program.
4. The output square root value stored in a location 4500h.

PROGRAM:

Memory Location	Label	Opcode	Mnemonics	Comments
4100	Origin:	90 42 00	MOV DPTR,#4200h	Get a input data
4103		e0	MOVX A,@DPTR	
4104		f9	MOV R1,a	
4105		7a 01	MOV R2, #01h	Initialize counter
4107	LOOPI:	e9	MOV A,R1	
4108		8a f0	MOV B,R2	
410a		84	DIV AB	divide the given value and counter
410b		fb	MOV R3,A	
410c		ac f0	MOV R4,B	
410e		9a	SUBB A ,R2	compare
410f		60 03	JZ RESULT	Dividend and counter
4111		0a	INC R2	
4112		80 f3	SJMP L1	

SAMPLE INPUT AND OUTPUT:

ML	Input
4200	40(hex value)=64(decimal)

ML	Output
4500	8

Result:

Thus an assembly language program is written to find the square root of a given data and executed successfully.

Viva questions:

1) How to square the number?
2) How different is squaring from multiplication?
3) What is the complexity involved in finding the square root?
4) How many iterations needed?
5) How many registers are involved?
6) What is the complexity involved?

16. Seven segment display

Aim:

To write an assembly language program to display characters on a seven display interface.

Apparatus required:

8051 microcontroller kit

(0-5V) DC battery

Algorithm:

1. Enter a program.
2. Initialize number of digits to Scan
3. Select the digit position through the port address C0
4. Display the characters through the output at address C8.
5. Check whether all the digits are display.
6. Repeat the Process.

PROGRAM:

Memory Location	Label	Opcode	Mnemonics	Comments
4100	START	90 41 2B	DPTR, #TABLE	Display message
4103		AA 82	MOV R2, DPL	
4105		AB 83	MOV R3, DPH	
4107		78 07	MOV R0, #07H	
4109		7F 08	MOV R7, #08H	Initialize no.of digits to Scan
410B	L1	E8	MOV A, R0	Select digit position
410C		90 FF C0	MOV DPTR, #0FFC0H	
410F		F0	MOVX @DPTR, A	
4110		8A 82	MOV DPL, R2	
4112		8B 83	MOV DPH, R3	
4114		E0	MOVX A, @DPTR	
4115		90 FF C8	MOV DPTR, #0FFC8H	
4118		F0	MOVX @DPTR, A	
4119		12 41 22	LCALL DELAY	
411C		0A	INC R2	
411D		18	DEC R0	Check if 8 digits are Displayed
411E		DF EB	DJNZ R7, L1	If not repeat
4120		21 00	AJMP START	Repeat from the 1st digit
4122	DELAY	7C 02	MOV R4, #02H	
4124	L3	7D FF	MOV R5, #0FFH	
4126	L2	DD FE	DJNZ R5, R2	
4128		DC FA	DJNZ R4, L3	
412A		22	RET	
412B	TABLE	3E 06 00 55	DB 3EH, 06H, 00H, 55H	
412F		06 39 50 3F	DB 06H, 39H, 50H, 3FH	
4133			END	

SAMPLE INPUT AND OUTPUT:

Sl.No	Input (hex Values)	Output (Characters)

Result:

Thus an assembly language program displaying characters on seven segment display has been executed.

Viva questions:

1. What are the different types of LED displays?
2. What is 7 segment display?
3. How to change the intensity of display light?
4. How many segments can be connected to 8051 controller?
5. What is the driving strength?

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