WINTER– 17 EXAMINATION

Subject Name: Microcontroller **Model Answer** Subject Code: 17534

Important Instructions to examiners:

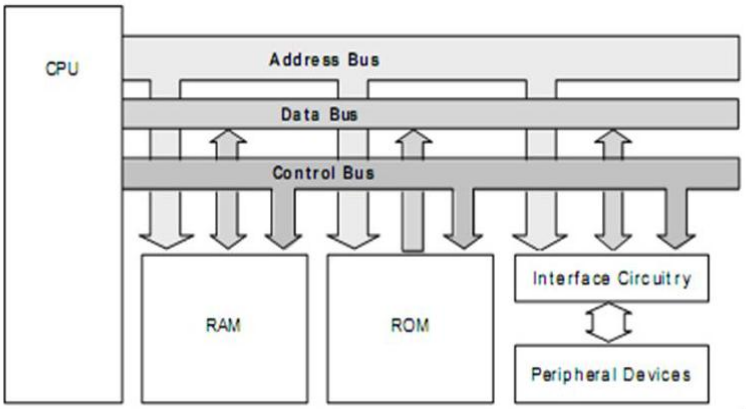
1) The answers should be examined by key words and not as word-to-word as given in the model answer scheme.
2) The model answer and the answer written by candidate may vary but the examiner may try to assess the understanding level of the candidate.
3) The language errors such as grammatical, spelling errors should not be given more Importance (Not applicable for subject English and Communication Skills.
4) While assessing figures, examiner may give credit for principal components indicated in the figure. The figures drawn by candidate and model answer may vary. The examiner may give credit for any equivalent figure drawn.
5) Credits may be given step wise for numerical problems. In some cases, the assumed constant values may vary and there may be some difference in the candidate's answers and model answer.
6) In case of some questions credit may be given by judgement on part of examiner of relevant answer based on candidate's understanding.
7) For programming language papers, credit may be given to any other program based on equivalent concept.

1. a) Attempt any THREE of the following:

i) Draw the basic block diagram of microcomputer and state the function of each elements in a computer.

Ans: (2M-diagram, 2M-function)

Any relevant and correct explanation should be given marks.



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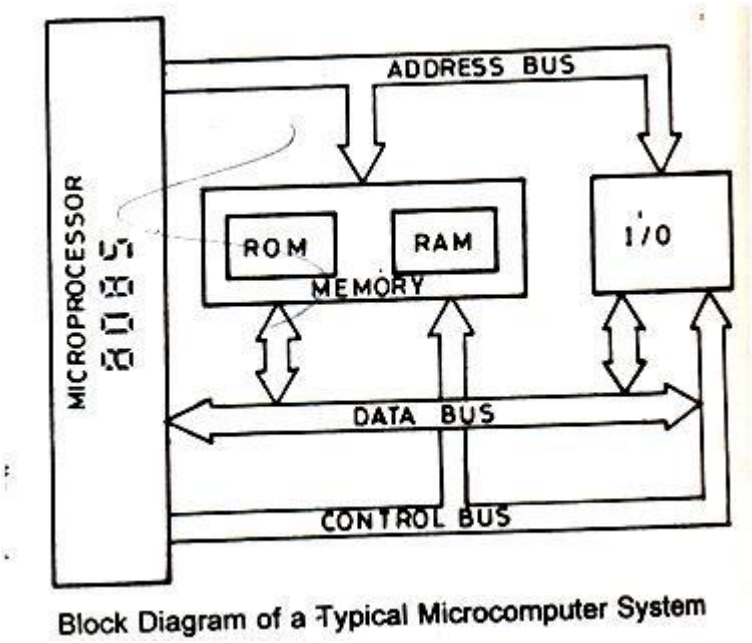


Block Diagram of a Typical Microcomputer System

CPU: central processing unit is the heart of Microcomputer. It read instructions from ROM and data from RAM memory and process on it.

ROM: Read only memory is used to store the program codes.

RAM: Random Access Memory is used for temporary storage.

ii) **Distinguish between Microprocessor and Microcontroller (any four).**

Ans: (1M-each correct point)

Sr. No	Parameter	Microprocessor	Microcontroller
1.	No. of instructions used	Many instructions to read/ write data to/ from external memory.	Few instruction to read/ write data to/ from external memory
2.	Memory	Do not have inbuilt RAM or ROM.	Inbuilt RAM /or ROM
3.	Registers	Microprocessor contains general purpose registers, Stack pointer register, Program counter register	Microcontroller contains general purpose registers, Stack pointer register, Program counter register additional to that it contains Special Function Registers (SFRs) for Timer , Interrupt and serial communication etc.
4.	Timer	Do not have inbuilt Timer.	Inbuilt Timer
5.	I/O ports	I/O ports are not available requires extra device like 8155 or 8255.	I/O ports are available
6.	Serial port	Do not have inbuilt serial port, requires extra devices like 8250 or 8251.	Inbuilt serial port
7.	Multifunction pins	Less Multifunction pins on IC.	Many multifunction pins on the IC
8.	Boolean Operation	Boolean operation is not possible directly.	Boolean Operation i.e. operation on individual bit is possible directly
9.	Applications	General purpose, Computers and Personal Uses.	Single purpose(dedicated application), Automobile companies, embedded systems, remote control devices.

iii) What is PSW? Draw the format of PSW register of 8051 and state the function of each bit.

Ans: (2M-format ,2M-definition and function)

PSW stands for Program status word. It is a flag register. It provides math and control flags.

CY	AC	F0	RS1	RS0	OV	--	P

CY	PSW.7	Carry Flag.
AC	PSW.6	Auxiliary carry flag.
F0	PSW.5	Available to the user for general purpose.
RS1	PSW.4	Register bank selector bit 1.
RS0	PSW.3	Register bank selector bit 0.
OV	PSW.2	Overflow flag.
--	PSW.1	User- definable bit.
P	PSW.0	Parity flag. Set/cleared by hardware each instruction cycle to indicate and Odd/ even number of 1 bit in the accumulator.

1. CY: Carry flag.

This flag is set whenever there is a carry out from the D7 bit. The flag bit is affected after an 8 bit addition or subtraction. It can also be set to 1 or 0 directly by an instruction such as "SETB C" and CLR C" where "SETB C" stands for "set bit carry" and "CLR C" for "clear carry".

2. AC: Auxiliary carry flag

If there is a carry from D3 and D4 during an ADD or SUB operation, this bit is set; it is cleared. This flag is used by instructions that perform BCD (binary coded decimal) arithmetic.

3. F0: Available to the user for general purposes.

4. RS0, RS1: Register bank selects bits

These two bits are used to select one of the four register banks from internal RAM as shown in given table. By writing zeroes and ones to these bits, a group of registers R_0- R_7 can be used out of four registers banks in internal RAM. The user can use only one bank of register at one time. By default , bank 0 gets selected.

RS1	RS0	Space in RAM
0	0	Bank 0 (00H- 07H)
0	1	Bank 1 (08H-0FH)
1	0	Bank2 (10H-17H)
1	1	Bank3 (18H-1FH)

5. OV: Overflow flag

This flag is set whenever the result of a signed number operation is too large, causing the high- order bit to overflow into the sign bit. In general, the carry flag is used to detect errors in unsigned arithmetic operations. The overflow flag is only used to detect errors in signed arithmetic operations.

6. P: Parity flag

The parity flag reflects the number of 1s in the A (accumulator) register only. If the A register contains an odd number of 1s, then P=1. P=0 if A has an even number of 1s

iv) State the function of 1) editor 2) assembler 3)linker 4) compiler.

Ans: (1M-each definition)

1) Editor: An editor is a program which helps you to construct your assembly language program in right format so that the assembler will translate it correctly to machine language. So, you can type your program using editor. This form of your program is called as source program and extension of

program must be .asm or .src depending on which assembler is used. The DOS based editor such as EDIT, WordStar, and Norton Editor etc. can be used to type your program.

2) Assembler: An assembler is programs that translate assembly language program to the correct binary/hex code for each instruction i.e. machine code and generate the file called as Object file with extension .obj and list file with extension .lst extension.

It is used to find syntax error in the program.

Some examples of assembler are ASEM-51, Kiel's A51, AX 51 and C51, Intel PL/M-51 etc.

3) Compiler: Compiler is programs that translate C language program to the correct binary/hex code for each command i.e. machine code and generate the file called as Object file with extension .obj and list file with extension .lst extension.

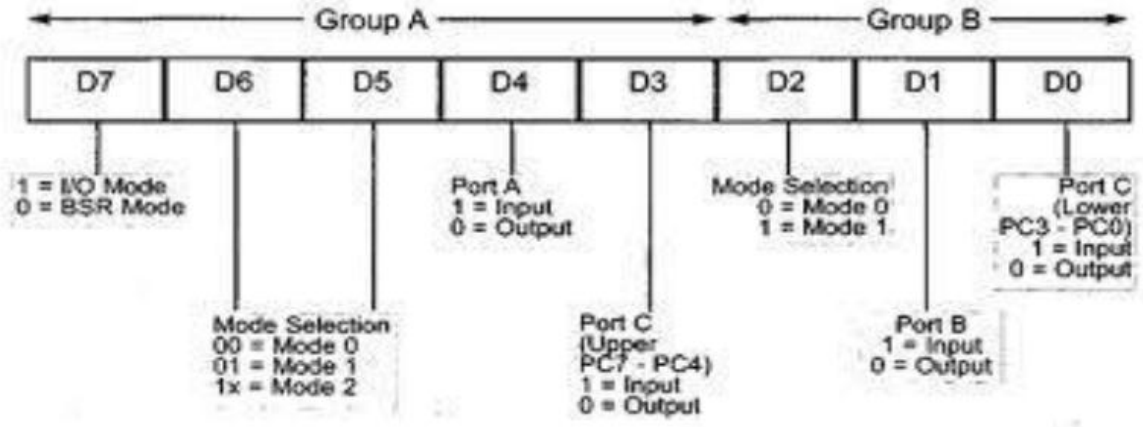
It is used to find syntax error in the program.

4) Linker: A linker is a program, which combines, if requested, more than one separately assembled object files into one executable program, such as two or more programs and also generate .abs file and initializes it with special instructions to facilitate its subsequent loading the execution.

Some examples of linker are ASEM-51 BL51, Keil u Vision Debugger, LX 51 Enhanced Linker etc.

v) Draw and describe the control word format of 8255.

Ans: (2M-format,2M-description)



b) Attempt any ONE of the following:

i) Write an ALP to find the largest number from a block of ten bytes of data stored in RAM location starting from 40H .Store the largest number at 50H.

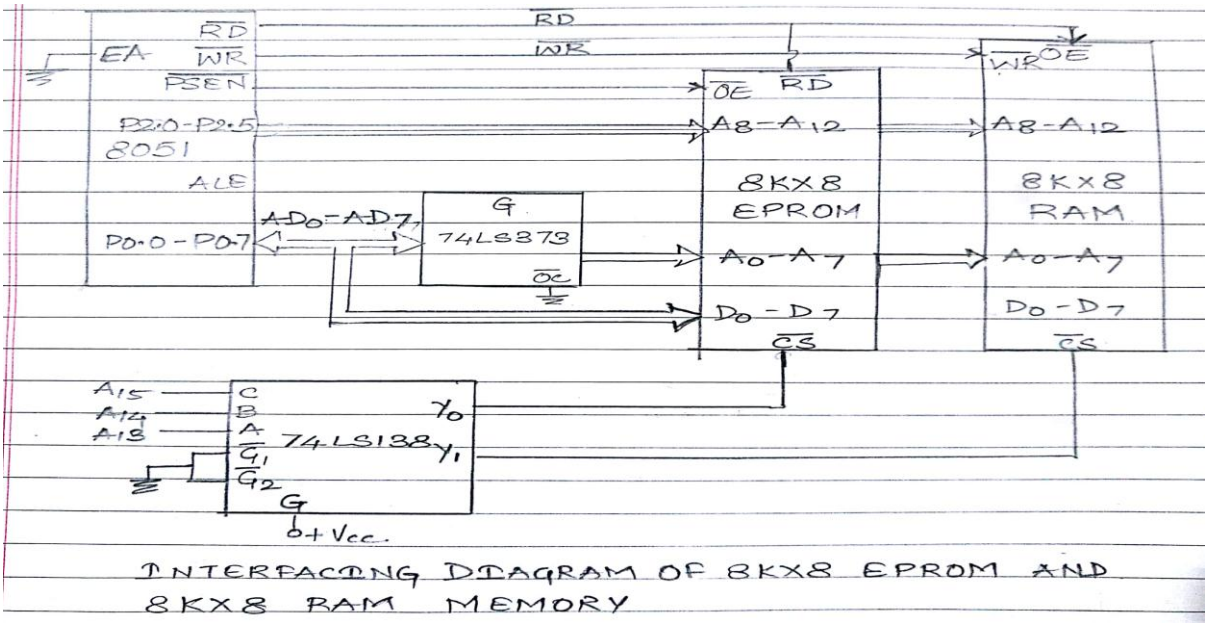
Ans: (6M- for correct program)

Program:

```
                Org 0000h
                Sjmp start
                Org 0030h
Start:          MOV R1, #0AH            ; initialize the counter
                MOV A, #00h             ;Assume largest no=00h
                MOV R0, #40H            ; initialize the memory pointer
                MOV 02h,@R0             ; load number in register R2
                CJNE A, 02h, NEXT       ;compare A & R2, if R2>A, replace A by R2
NEXT:           JNC SKIP
```

```
        MOV A, R2
SKIP:   INC R0                  ; increment the memory pointer
        DJNZ R1, UP             ; decrement the counter by one, if count
                                ≠0, then go to UP
        MOV 50H, A              ; store result at memory location 50H
HERE:   SJMP HERE
        END
```

ii) Draw interfacing diagram of 8Kbyte EPROM and 8K byte RAM to 8051 microcontroller. Draw the memory map.
Ans: (4M- interfacing diagram,2M- memory map)



INTERFACING DIAGRAM OF 8KX8 EPROM AND 8KX8 RAM MEMORY

	A15	A14	A13	A12	A11	A10	A9	A8	A7	A6	A5	A4	A3	A2	A1	A0	ADDR
Start addr Of EPROM	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0000H**
End addr Of EPROM	**0**	**0**	**0**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1FFFH**

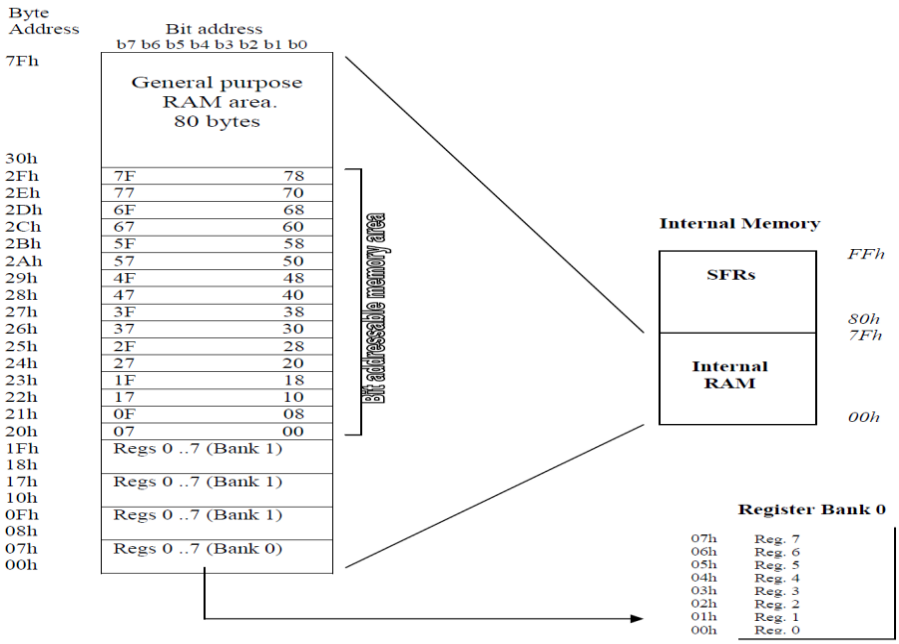
Start addr Of RAM	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0000H**
End addr of RAM	**0**	**0**	**0**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1FFFH**

Note:1) If CS of both RAM and ROM is connected to ground is also correct. As 8051 is Harvard architecture, there is separate space for RAM and ROM therefore starting address of RAM is 0000h as well as for ROM also 0000h. students can use different decoding logic for /CS.
2) /RD of EPROM is to be connected to /PSEN and not to /RD.

2. Attempt any FOUR of the following:

a) Draw the internal RAM memory organization of 8051 microcontroller with the address location.

Ans:(4M-correct diagram)



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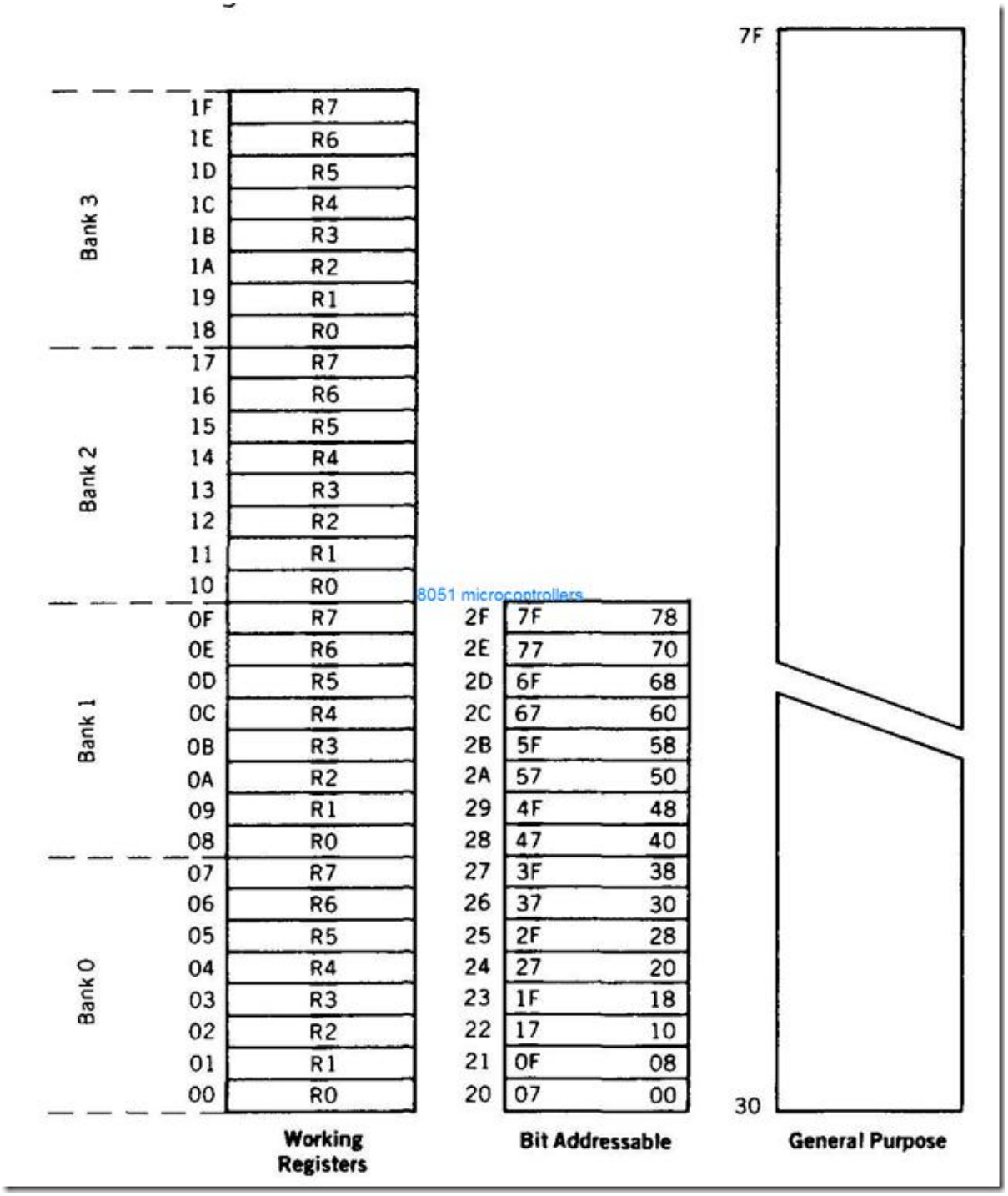


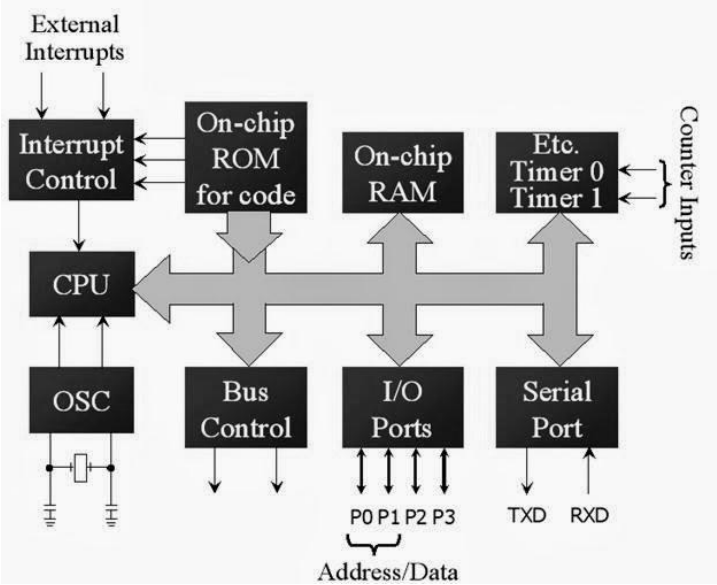
b) Compare 8031,8051and 8751(four points)
Ans: 1M each- for correct point)

specification	8031	8051	8751
On chip data memory	128 byte	128 byte	128 byte

On chip program memory	ROM less	4K ROM	4K EPROM
Number of 16 bit timer/counter	2	2	2
Number of vectored interrupts	5	5	5
Full duplex serial I/O	1	1	1
On chip peripherals	UART	UART	UART
No of I/o lines	32	32	32
Speed MHz	12	12	12

c) Draw a neat labeled architectural block diagram of 8051 microcontroller.

Ans: (4M- correct diagram)



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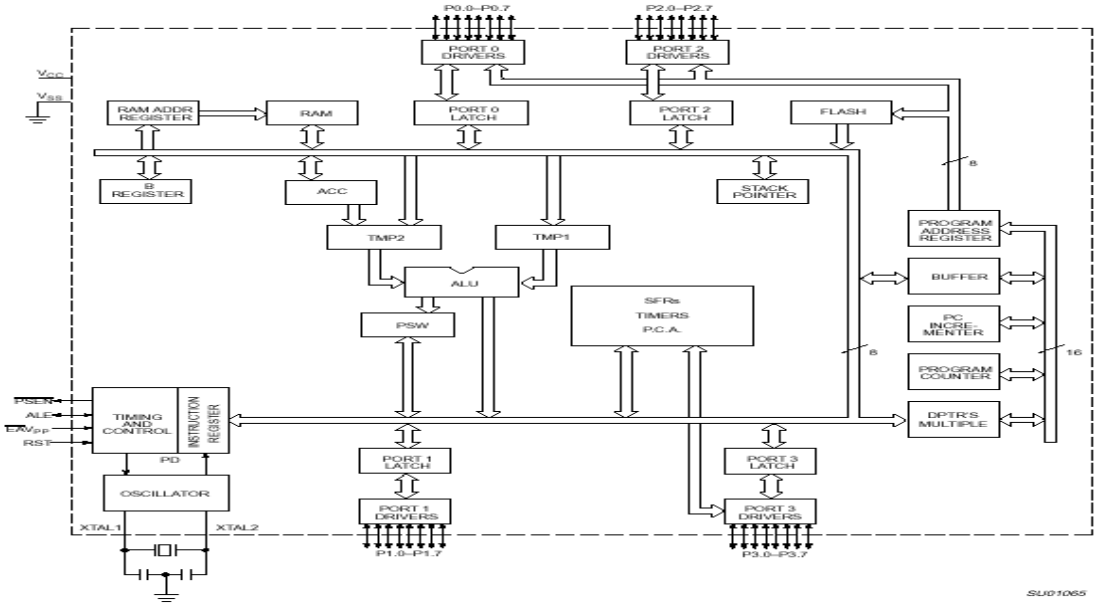


d) **State all the alternate functions of port 3 of 8051 microcontroller.**
Ans: (1/2M- each point)

Pin	Name	Alternate Function
P3.0	RXD	Serial input line(Receive)
P3.1	TXD	Serial output line(Transmit)
P3.2	$\overline{\text{INT0}}$	External interrupt 0
P3.3	$\overline{\text{INT1}}$	External interrupt 1
P3.4	T0	Timer 0 external input
P3.5	T1	Timer 1 external input
P3.6	$\overline{\text{WR}}$	External data memory write strobe
P3.7	$\overline{\text{RD}}$	External data memory read strobe

e) Describe the function of following pins of 8051 microcontroller
i) T0
ii)INT0
iii)PSEN
iv)RST
Ans: (1M- each function)
i) T0: It is I/P signal to internal timer-0 circuit. External clock pulses can connect to timer-0 through this I/P signal. It is pin no. 14, P3.4 pin of 8051
ii) INT0\: There are two external hardware interrupts- INT0 and INT1. INT0 has the highest priority of 1 and Timer 0 comes next with priority value 2. The order of priority works like this – consider a case where two interrupts are raised at the same time – one from INT0 and another from Timer 1 interrupt.

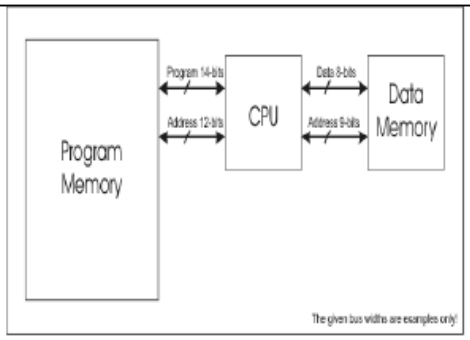
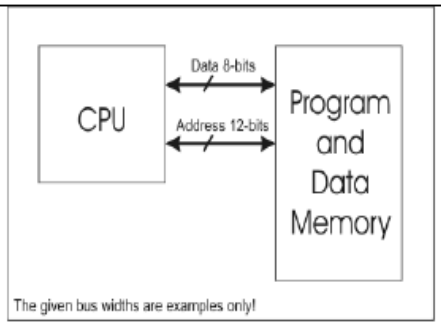
In such a case, processor would serve the interrupt according to it's priority. In our case INT0 is of high priority (priority order 1)and Timer 1 interrupt is of low priority (priority order 4). So processor will execute ISR of INTO first and then later, after finishing ISR of INT0, processor will begin executing ISR of Timer 1 interrupt.

iii) PSEN\: PSEN stands for "program store enable." In an 8031-based system in which an external ROM holds the program code, this pin is connected to the /OE pin of the ROM. In other words, to access external ROM containing program code, the 8031/51 uses the PSEN signal. When the EA pin is connected to GND, the 8031/51 fetches opcode from external ROM by using PSEN. In systems based on the 8751/89C51/ DS5000 where EA is connected to VCC, these chips do not activate the PSEN pin. This indicates that the on- chip ROM contains program code.

iv) RST: RST stands for reset. The RST pin of 8051 is made high for two machine cycles, while the oscillator is running. A power on reset circuit is used. A pull down resistor of 8.2K form the RST pin to Vss and a capacitor of 10uf from the reset circuit. These component values are sufficient to provide a delay, so as to make the RST line high for 24 oscillations. To support the manual reset function, if desired so, a switch may be added across the 10uf capacitor.

f) Compare Von-Neumann and Harvard architecture (Four points)

Ans: 1M-each correct point

Sr. No	Harvard Architecture	Van Neumann's Architecture
1.		
2.	The Harvard architecture uses physically separate memories for their instructions and data.	The Van Neumann's architecture uses single memory for their instructions and data.
3.	Requires separate & dedicated buses for memories for instructions and data	Requires single bus for instructions and data.
4.	Its design is complicated	Its design is simpler.
5.	Instructions and data can be fetched simultaneously as there is separate buses for instructions and data which increasing operation bandwidth.	Instructions and data have to be fetched in sequential order limiting the operation bandwidth.

Q3 Attempt any four of the following

a) What are assembler directives? State and describe any three directives with one example each
Ans (1 mark assembler directives , 1 M each directive any three 3 marks)

. Unlike instructions being compiled and written to chip program memory, directives are commands of assembly language itself and have no influence on the operation of the microcontroller. Some of them are obligatory part of every program while some are used only to facilitate or speed up the operation. Directives are written in the column reserved for instructions. There is a rule allowing only one directive per program line.

1) ORG: ORG stands for Origin

Syntax:

ORG Address

The ORG directive is used to indicate the beginning of the address. The number that comes after ORG can be either in hex or in decimal. If the number is not followed by H, it is decimal and the assembler will convert it to hex. Some assemblers use **—.**ORG (notice the dot) instead of **—**ORG for the origin directive.

2) DB:- (Data Byte)
Syntax:

Label: DB Byte

Where byte is an 8-bit number represented in either binary, Hex, decimal or ASCII form. There should be at least one space between label & DB. The colon (:) must present after label. This directive can be used at the beginning of program. The label will be used in program instead of actual byte. There should be at least one space between DB & a byte. Following are some DB examples:

LOOKUP: DB 30h,31h,32h,33h,34h,35h

3) EQU: Equate
Format

LABEL EQU ADDRESS

e.g.

VALUE EQU 60h
MOV VALUE,#25h

4) END:
This assembler directive is used to end the program. No commands or instructions will be accepted after end.

5) CODE directive
The CODE directive is used to assign a symbol to a program memory address. Since the maximum capacity of program memory is 64K, the address must be in the range of 0 to 65535.

6) DATA:

Syntax:

Name	Data	Data Address

By means of this directive an address with internal RAM is designated as a symbol (address must be in the range of 0-255). In other words, any selected register may change its name or be assigned a new one. For e.g. TEMP 12 DATA 32:- register at address 32 is named as "TEMP 12".

b)Write an ALP to multiply two 8 bit numbers stored at 20H and 21H in internal RAM.Store result in 22h and 23H.

Ans: (4 marks-prog)

Program:

```
        Org 0000h
        Sjmp start
        Org 0030h
start:  MOV SP,#30h
        MOV 20H, # 23H          ; store first 8-bit no. in 20H
        MOV 21H, #15H           ; store second 8-bit no. in 21H
```

(Note: Students can skip above two instructions)

```
        MOV A, 20H              ; move first number to A
        MOV B, 21H              ; move second number to B
        MUL AB                  ; multiply the numbers
        MOV 22H, A              ; move LSB to 22H
        MOV 23H, B              ; move MSB to 23H
HERE:   SJMP HERE
        END
```

C)Describe the function of following instruction of 8051 mic.

1)RLC A II) XRL A, 15H III) DIV AB IV) MOVX @DPTR, A

Ans: (1 m each instruction)

1)RLC A

Description: Rotate a byte and carry bit to the left: the carry becomes the LSB and the MSB becomes the carry

II) XRL A, 15H

Description: XOR each bit of A with the some bit of memory location 15H; put the result in A

III) DIV AB

Description Divide A and B ;put the interger part of quotient in A and the integer part of remainder in B

IV) MOVX @DPTR, A

Description: Copy yhe data from A to the external address given by DPTR.

d) State the addressing modes of 8051 mic. Describe any three with one example each.

Ans:**(list of modes – 1 marks, any three modes explanation – 3 marks)**

There are a number of addressing modes available to the 8051 instruction set, as follows:

1. Immediate Addressing mode
2. Register Addressing mode
3. Direct Addressing mode
4. Register Indirect addressing mode
5. Indexed Addressing mode

1) **Immediate Addressing mode:**

Immediate addressing simply means that the operand (which immediately follows the Instruction op. code) is the data value to be used.

For example the instruction:

MOV A, #25H; Load 25H into A

Move the value 25H into the accumulator. The # symbol tells the assembler that the immediate addressing mode is to be used.

2) Register Addressing Mode:

One of the eight general-registers, R0 to R7, can be specified as the instruction Operand. The assembly language documentation refers to a register generically as Rn.

An example instruction using register addressing is:

ADD A, R5;add the contents of register R5 to contents of A (accumulator)

Here the contents of R5 are added to the accumulator. One advantage of register addressing is that the instructions tend to be short, single byte instructions.

3) Direct Addressing Mode:

Direct addressing means that the data value is obtained directly from the memory location specified in the operand.

For example consider the instruction:

MOV R0, 40H; Save contents of RAM location 40H in R0.

The instruction reads the data from Internal RAM address 40H and stores this in theR0. Direct addressing can be used to access Internal RAM, including the SFR registers.

4) Register Indirect Addressing Mode:

Indirect addressing provides a powerful addressing capability, which needs to be appreciated.

An example instruction, which uses indirect addressing, is as follows:

MOV A, @R0; move contents of RAM location whose address is held by R0 into A

Note the @ symbol indicated that the indirect addressing mode is used. If the data is inside the CPU, only registers R0 & R1 are used for this purpose.

5) Indexed Addressing Mode:

With indexed addressing a separate register, either the program counter, PC, or the data pointer DTPR, is used as a base address and the accumulator is used as an offset address. The effective address is formed by adding the value from the base address to the value from the offset address. Indexed addressing in the 8051 is used with the JMP or MOVC instructions. Look up tables are easy to implement with the help of index addressing.

Consider the example instruction:

MOVC A, @A+DPTR

MOVC is a move instruction, which moves data from the external code memory space. The address operand in this example is formed by adding the content of the DPTR register to the accumulator value. Here the DPTR value is referred to as the base address and the accumulator value us referred to as the index address

e)Write an ALP to send continuously message “HELLO” serially at 9600 baud rate.

Ans:(4M-for correct prog)

```
        Org 0000h

        Sjmp start
```

```
        Org 0030h
start:  MOV SP,#30h
        MOV TMOD, #20H                      ; timer 1, mode2
        MOV TH1,#-3 or MOV TH1,#0FDh        ; 9600 baud rate
        MOV SCON, #50H                      ; 8-bit data,1 stop bit, REN enabled
        SETB TR1                            ; Start timer 1
AGAIN:  MOV A, #"H"                         ; transfer "H"
        ACALL MESSAGE                       ; Some delay
        MOV A, #"E"                         ; transfer "E"
        ACALL MESSAGE
        MOV A, #"L"                         ; transfer "L"
        ACALL MESSAGE
        MOV A, #"L"                         ; transfer "L"
        ACALL MESSAGE
        MOV A, #"O"                         ; transfer "O"
        ACALL MESSAGE
        SJMP AGAIN
MESSAGE: MOV SBUF, A;
        JNB TI, HERE;
        CLR TI;
        RET
        end
```

Q4 a) Attempt any three of the following:

i) Write an ALP to calculate the sum of five consecutive numbers stored from memory location starting at 20h.Store the lower byte at memory location 25h and higher byte at 26h (4 marks)
Ans:

Program for addition of five 8 bit nos.

```
        Org 0000h
        Sjmp start
        Org 0030h
Start:  MOV R0, #05H      ; Initialize byte counter
        MOV R1, #20H      ; Initialize memory pointer
        MOV R7,#00H       ;Initialize higher byte counter
        MOV A, # 00H      ; Clear Accumulator
  UP:   ADD A @R1         ; Add accumulator with number from array
        JNC  Next         ;if cy-0,then go to next
        INC  R7                 ;increment R7(for carry)
 Next:  INC R1                  ; Increment memory pointer
        DJNZ R0, UP       ; Decrement byte counter, if not zero add again
        MOV25H, A         ; Store lower byte of result in internal memory
        MOV 26H,R7        ;Store higher byte of result in internal memory
HERE:   SJMP HERE   ; Stop
        end
```

ii) Write an ALP to receive serial data bytes and put them in port P1.Assume baud rate of 4800, 8 bit data, 1 stop bit. (4 marks)

Ans:

```
        Org 0000h
        Sjmp start
        Org 0030h
Start:  MOV TMOD, #20H                  ; timer 1, mode 2
        MOV TH1, #-6 or MOV TH1,#0FAh                   ; 4800 baud
        MOV SCON, # 50H                 ; 8-bit data, I stop bit, REN enabled
```

```
        SETB TR1                    ; start timer1
HERE:   JNB RI HERE                 ; wait for the character to come in
        MOV A, SBUF                 ; save incoming byte in A
        MOV P1,A                    ; send to port 1
        CLR RI                      ; get ready to receive next byte
        sjmp HERE                   ; continue receiving process.
        END
```

iii) Draw the format of SCON register of 8051 and explain the function of each bit.
Ans:(SCON register format - -2 Marks, Explanation of each bit --2 Marks)

SM0	SM1	SM2	REN	TB8	RB8	TI	RI

SM0	SCON.7	Serial port mode specifier
SM1	SCON.6	Serial port mode specifier.
SM2	SCON.5	Used for multiprocessor communication (Makeit0.)
REN	SCON.4	Set/cleared by software to enable/ disable reception.
TB8	SCON.3	9^{th} bit to be transmitted in mode 2 and 3.
RB8	SCON.2	9th received bit in mode 2 and 3.
TI	SCON.1	Transmit interrupt flag. Set by hardware at the beginning of the stop Bit in mode1. Must be cleared by software.
RI	SCON.0	Receive interrupt flag. Set by hardware halfway through the stop bit time in mode 1. Must be cleared be cleaned by

Note: Make SM2, TB8 and RB8=0.

SM0	SM1	
0	0	Serial Mode0
0	1	Serial Mode1, 8-bit data, 1 stop bit, 1 start bit
1	0	Serial Mode2
1	1	Serial Mode3

iv) With the help of suitable diagram describe the modes of serial communication in 8051.

Ans: (1M each mode)

8051 micro controller communicate with another peripheral device through RXD and TXD pin of port3.controller have four mode of serial communication.

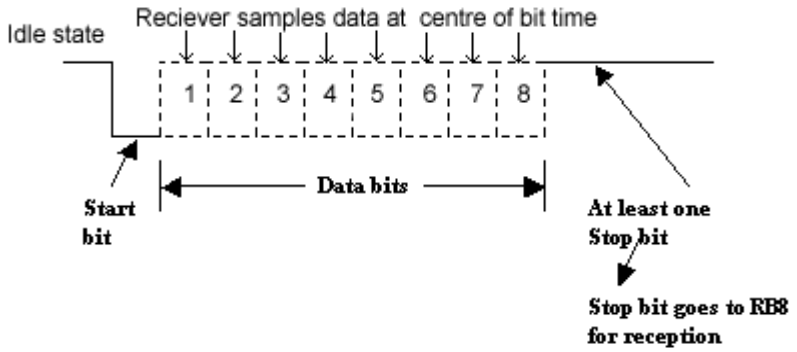
1. Mode-0 Shift Register Mode (Baud Rate Fixed)

In this mode, the serial port works like a shift register and the data transmission works synchronously with a clock frequency of fosc /12. Serial data is received and transmitted through RXD. 8 bits are transmitted/ received at a time. Pin TXD outputs the shift clock pulses of frequency fosc /12, which is connected to the external circuitry for synchronization. The shift frequency or baud rate is always 1/12 of the oscillator frequency.

2. Mode-1 : 8-bit UART mode (baud rate is variable)

In mode-1, the serial port functions as a standard Universal Asynchronous Receiver Transmitter

(UART) mode. 10 bits are transmitted through TXD or received through RXD. The 10 bits consist of one start bit (which is usually '0'), 8 data bits (LSB is sent first/received first), and a stop bit (which is usually '1'). Once received, the stop bit goes into RB8 in the special function register SCON. The **baud rate is variable**.



$$f_{baud} = \frac{2^{SMOD}}{32} X \frac{fosc}{12 X [256-(TH1)]}$$

3. Mode-2 : 9 bit UART (baud rate is fixed)

In this mode 11 bits are transmitted through TXD or received through RXD.The various bits are as follows: a start bit (usually '0'), 8 data bits (LSB first), a programmable 9 th (TB8 or RB8)bit and a stop bit (usually '1'). While transmitting, the 9 th data bit (TB8 in SCON) can be assigned the value '0' or '1'. For example, if the information of parity is to be transmitted, the parity bit (P) in PSW could be moved into TB8.On reception of the data, the 9 th bit goes into RB8 in 'SCON', while the stop bit is ignored. The baud rate is programmable to either 1/32 or 1/64 of the oscillator frequency.

f baud = (2 SMOD /64) fosc

4. Mode-3 – 9 bit UART (Variable baud rate)

In this mode 11 bits are transmitted through TXD or received through RXD. The various bits are: a start bit (usually '0'), 8 data bits (LSB first), a programmable 9 th bit and a stop bit (usually '1'). Mode-3 is same as mode-2, except the fact that the baud rate in mode-3 is variable (i.e., just as in mode-1).

f baud = (2 SMOD /32) * (fosc / 12 (256-TH1))

b) Attempt any one of the following:

i) Describe the following instructions of 8051 (each instruction 1 ½ marks)

1) XCHD A,@R1

2)ORL A,R0

3)SETB 00H

4)INC DPTR

Ans

1)XCHD A , @R_I

Description: The XCHD instructions exchanges only the lower nibble of A with the lower nibble of the RAM location pointed to by Ri while leaving the upper nibbles in both places intact

2) ORL A,R0

Description :OR each bit of A with the same bit of register R0 and result is stored in A.

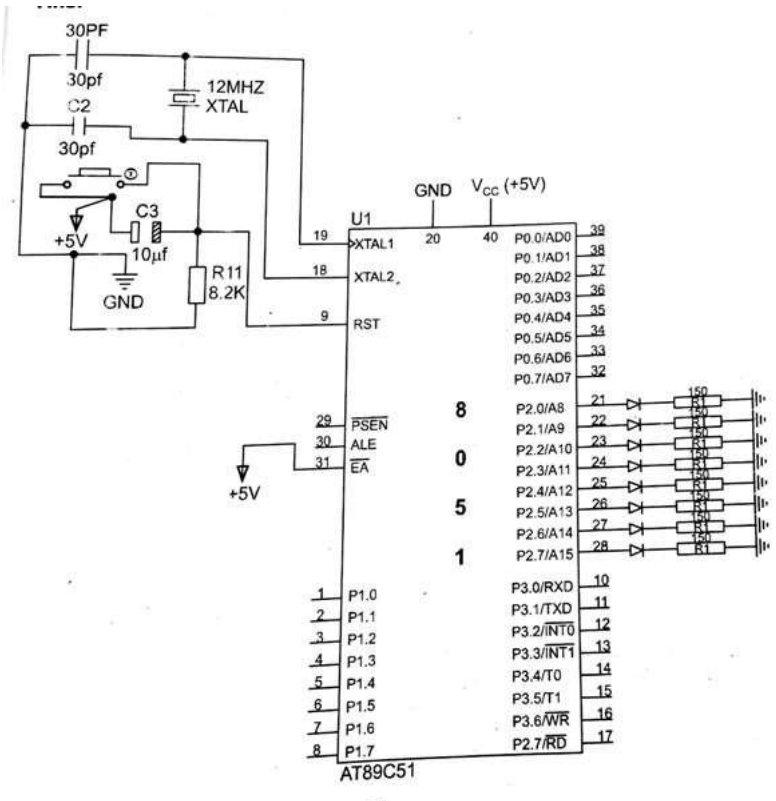
3) SETB 00H

Description : Set the bit addressable bit i.e 00H to 1

4) INC DPTR

Description :Add a 1 to the 16 bit DPTR register.

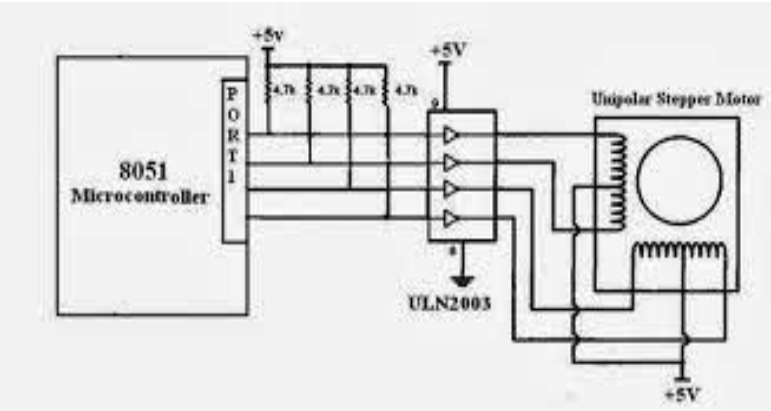
ii) Draw the interfacing diagram of 8 LED's to port 2 of 8051 mic. Write an ALP to turn these LED'S ON and OFF after a certain delay. (3 marks diagram , 3 marks program)



Program

```
                Org 0000h
                Sjmp start
                Org 0030h
Start:          MOV SP,#30h
                MOV A, # 0FFH              ; Store FFH in A
BACK:           MOV P2, A                  ; move FF to P2 to glow all the LEDs
                ACALL DELAY                : wait for some time
                CPL A                      ; turn off the LEDs
                SJMP BACK
DELAY:          MOV R3, #255
AGAIN:          DJNZ R3, AGAIN
                RET
                End
```

iii) Draw the interfacing diagram of stepper motor with 8051 microcontroller. Write an ALP to rotate motor continuously in clockwise direction. (3 marks diagram , 3 marks program)



Program

```
        Org 0000h
        Sjmp start
        Org 0030h
Start:  MOV SP,#30h
        MOV A,#66H      ;load step sequence
BACK:   MOV P1,A        ;issue sequence to motor
        RRA             ;rotate  right clockwise
        ACALL DELAY     ;wait
        SJMP BACK       ;keep going

DELAY:  MOV R2,#100
H1:     MOV R3,#255
H2:     DJNZ R3,H2
        DJNZ R2,H1
        RET
        End
```

Or

```
        Org 0000h
        Sjmp start
        Org 0030h
Start:  MOV SP,#30h
AGAIN:  MOV R1,#4
BACK:   MOV A,#00H
        MOV DPTR,#2000h
        MOVC A,@A+DPTR
        MOV P1,A        ;issue sequence to motor
        ACALL DELAY     ;wait
        INC DPTR
        DJNZ R1,BACK
        SJMP AGAIN      ;keep going

DELAY:  MOV R2,#100
H1:     MOV R3,#255
H2:     DJNZ R3,H2
        DJNZ R2,H1
        RET
EXCIT:  db 03h,06h,0ch,09h
        End
```

Q 5. Attempt any four of the following:

a) State the different timer modes of 8051.Describe mode 2 in detail.(2 marks modes and 2 marks description of mode-2)

M1	M0	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

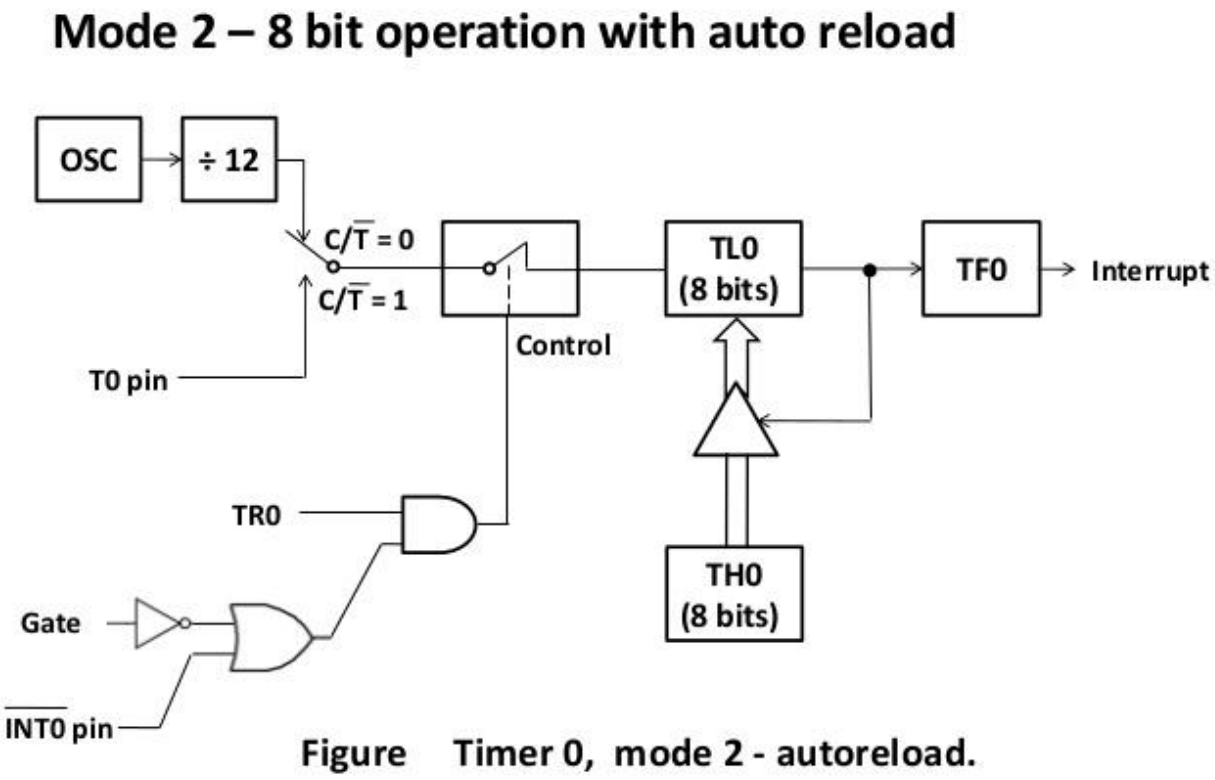


Figure Timer 0, mode 2 - autoreload.

In this mode only TLX is used as 8-bit counter. THX is used to hold the value which is loaded in TLX initially. Every time TLX overflows from FFH to 00H the timer flag is set and the value from THX is automatically reloaded in TLX register.

b) **Write a program to generate a square wave of 50% duty cycle on P1.5 bit. Timer 0 is used to generate the time delay**.

Ans :4 marks correct program

50% duty cycle so on time and off time is same. Assume square wave of 1khz so Ton and Toff will be 500µ sec.

I/P clock = $(11.059 \text{ X } 10^6)/12 = 1000000 = 921.58\text{KHz}$

$T_{in} = 1.085\mu$ sec

For 1 kHz square wave

$F_{out} = 1$ KHz

Ton= $1/ 1\text{X } 10^3$

Ton = 1000μ sec

Consider half of it = Ton = 500μ sec

$N = \text{Ton} / T_{in} = 500/1.085 = 460.82$

$65536\text{-}461 = (65075)_{10} = (FE33)_{16}$

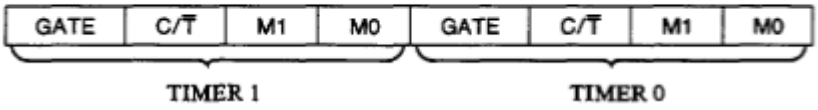
NOTE: Students can consider any frequency with 50% duty cycle. Accordingly TH0 and TL0 will change. They can consider even timer 1.

```
            ORG   0000
MOV         TMOD,# 01H ; Mode 1,timer 0
HERE :      MOV        TL0,# 33H        ; Lower byte of timer 0
            MOV        TH0, # 0FF       ;Higher byte of timer 0
            CPL        P1.5             ; toggle P 1.5
            ACALL      DELAY
            SJMP       HERE
delay using timer 0
DELAY :     SETB       TR0              ; Start time 0
AGAIN :     JNB        TF0, AGAIN
            CLR        TR0              ; Stop timer 0
            CLR        TF0
            RET
```

c) Draw and explain each bit of TMOD register of 8051.

Ans:- (Format- 2 mks, function of each bit-2 mks)

TMOD: TIMER/COUNTER MODE CONTROL REGISTER. NOT BIT ADDRESSABLE.



GATE When TRx (in TCON) is set and GATE = 1, TIMER/COUNTERx will run only while INTx pin is high (hardware control). When GATE = 0, TIMER/COUNTERx will run only while TRx = 1 (software control).

C/T Timer or Counter selector. Cleared for Timer operation (input from internal system clock). Set for Counter operation (input from Tx input pin).

M1 Mode selector bit. (NOTE 1)

M0 Mode selector bit. (NOTE 1)

NOTE 1:

M1	M0		Operating Mode
0	0	0	13-bit Timer (MCS-48 compatible)
0	1	1	16-bit Timer/Counter
1	0	2	8-bit Auto-Reload Timer/Counter
1	1	3	(Timer 0) TL0 is an 8-bit Timer/Counter controlled by the standard Timer 0 control bits, TH0 is an 8-bit Timer and is controlled by Timer 1 control bits.
1	1	3	(Timer 1) Timer/Counter 1 stopped.

d) **With crystal frequency of f=11.0592MHz,what value should be loaded into TH1 to have a 4800 baud rate? Give the answer in both hex and decimal** . (2 marks decimal and 2 marks hex value)

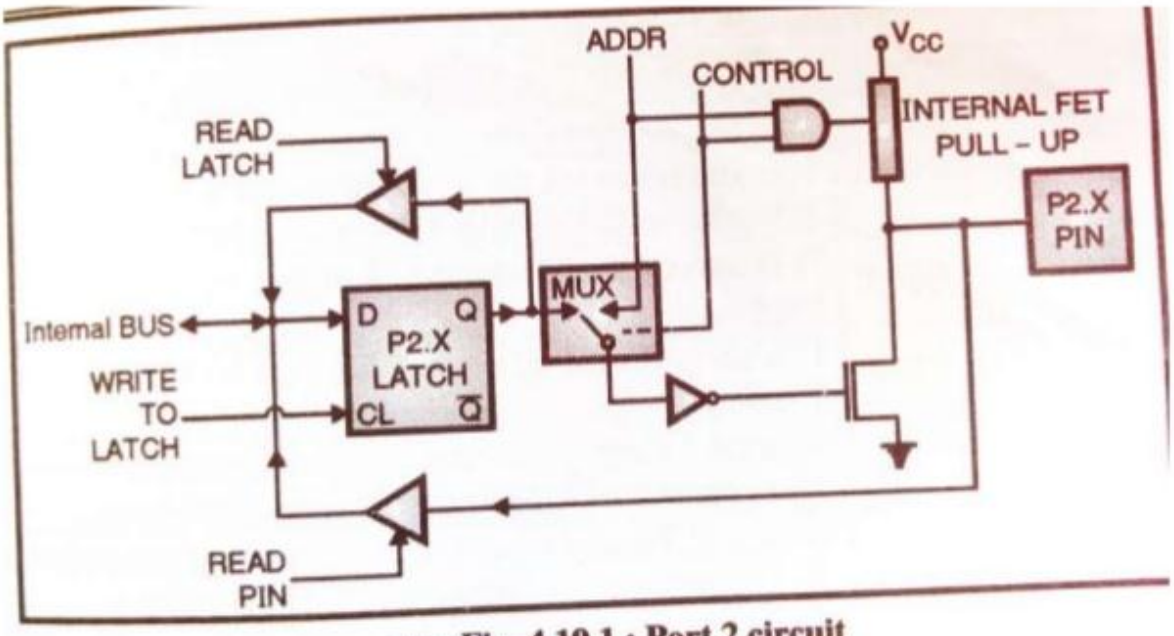
Baudrate	TH1 (Decimal)	Th1 (Hex)
4800	-6	FA

For 4800 baud rate value in decimal is -6

For 4800 baud rate value in hex is FA

e) Draw the circuit diagram of port 2 and describe its function. (2 marks circuit diagram,2 marks function)

Port "2"



m(23.5)**Fig. 4.19.1 : Port 2 circuit**

Port 2: It can be used as

a) Simple input/output port

b) the alternative use is to supply a higher order address byte in conjunction with the port 0 lower order byte to address external memory.

Q6)Attempt any FOUR of the following:

a)Draw the format of TCON register and describe function of each bit.

ANS: Format 2-marks and function -2 marks

TCON: TIMER/COUNTER CONTROL REGISTER. BIT ADDRESSABLE.

TF1	TR1	TF0	TR0	IE1	IT1	IE0	IT0

TF1 TCON. 7 Timer 1 overflows flag. Set by hardware when the Timer/Counter 1

Overflows. Cleared by hardware as processor vectors to the interrupt service routine.

TR1TCON. 6 Timer 1 run control bit. Set/cleared by software to turn Timer/Counter 1 ON/OFF.

TF0 TCON. 5 Timer 0 overflow flag. Set by hardware when the Timer/Counter 0 overflows. Cleared by hardware as processor vectors to the service routine.

TR0 TCON. 4 Timer 0 run control bit. Set/cleared by software to turn Timer/Counter 0 ON/OFF.

IE1 TCON. 3 External Interrupt 1 edge flag. Set by hardware when External Interrupt edge is detected. Cleared by hardware when interrupt is processed.

IT1 TCON. 2 Interrupt 1 type control bit. Set/cleared by software to specify

falling edge/low level triggered External Interrupt.

IE0 TCON. 1 External Interrupt 0 edge flag. Set by hardware when External

Interrupt edge detected. Cleared by hardware when interrupt is processed.

IT0 TCON. 0 Interrupt 0 type control bit. Set/cleared by software to

Specify falling edge/low level triggered External Interrupt

b) State the different types of interrupts in 8051 with their priorities and vector address. Ans:- (List 2 mks, priorities 1 mks, vector location -1 mks)

Interrupt Source	Vector address	Interrupt priority
External Interrupt 0 –INT0	0003H	1
Timer 0 Interrupt	000BH	2
External Interrupt 1 –INT1	0013H	3
Timer 1 Interrupt	001BH	4
Serial Interrupt	0023H	5

c) Differentiate between linear and absolute address decoding techniques(4 Points)

Ans: (1M each)

Absolute Decoding	Linear Decoding
1. It is also called as full decoding as all the address lines are used for decoding	It is also called as partial decoding as all address lines are not used for decoding
2. It is used in large memory systems.	It is used in small systems
3. Hardware required for decoding logicis more	Hardware used for decoding logic is eliminated.
4. Multiple addresses are not generated	Multiple addresses are generated

d) Draw the format of IE register and describe function of each bit.

Ans: **(2M- format, 2M –explanation)**

IE: INTERRUPT ENABLE REGISTER. BIT ADDRESSABLE.

If the bit is 0, the corresponding interrupt is disabled. If the bit is 1, the corresponding interrupt is enabled.

EA	—	ET2	ES	ET1	EX1	ET0	EX0

EA	IE.7	Disables all interrupts. If EA = 0, no interrupt will be acknowledged. If EA = 1, each interrupt source is individually enabled or disabled by setting or clearing its enable bit.
—	IE.6	Not implemented, reserved for future use.*
ET2	IE.5	Enable or disable the Timer 2 overflow or capture interrupt (8052 only).
ES	IE.4	Enable or disable the serial port interrupt.
ET1	IE.3	Enable or disable the Timer 1 overflow interrupt.
EX1	IE.2	Enable or disable External Interrupt 1.
ET0	IE.1	Enable or disable the Timer 0 overflow interrupt.
EX0	IE.0	Enable or disable External Interrupt 0.

*User software should not write 1s to reserved bits. These bits may be used in future MCS-51 products to invoke new features. In that case, the reset or inactive value of the new bit will be 0, and its active value will be 1.

e) Describe any four factors on which selection of microcontroller depends .(Each factor 1 mark)

Ans: The selection of microcontroller depends upon the type of application. The following factors must be

considered while selecting the microcontroller.

1. Word length: The word length of microcontroller is either 8, 16 or 32 bit. As the word length increases, the cost, power dissipation and speed of the microcontroller increases.
2. Power dissipation: It depends upon various factors like clock frequency, speed, supply voltage, VLSI technology etc. For battery operated embedded systems, we must use low power microcontrollers.
3. Clock frequency: The speed of an embedded system depends upon the clock frequency. The clock frequency depends upon the application.
4. Instruction Set: On the basis of instructions microcontrollers are classified into two categories 1. CISC 2. RISC.
   CISC system improves software flexibility. Hence it is used in general purpose systems.
   RISC improves speed of the system for the particular applications.
5. Internal resources: The internal resources are ROM, RAM, EEPROM, FLASH ROM, UART, TIMER, watch dog timer, PWM, ADC, DAC, network interface, wireless interface etc. It depends upon the application for which microcontroller is going to be used.
6. I/O capabilities: The number of I/O ports, size and characteristics of each I/O port, speed of operation of the I/O port, serial port or parallel ports. These are the considerations needed to ascertain.