



MAHARASHTRA STATE BOARD OF TECHNICAL EDUCATION
(Autonomous)
(ISO/IEC - 27001 - 2005 Certified)
WINTER-15 EXAMINATION
Model Answer Paper

Subject Code: 17626

Subject Name: Embedded Systems

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 judgment 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.

Marks

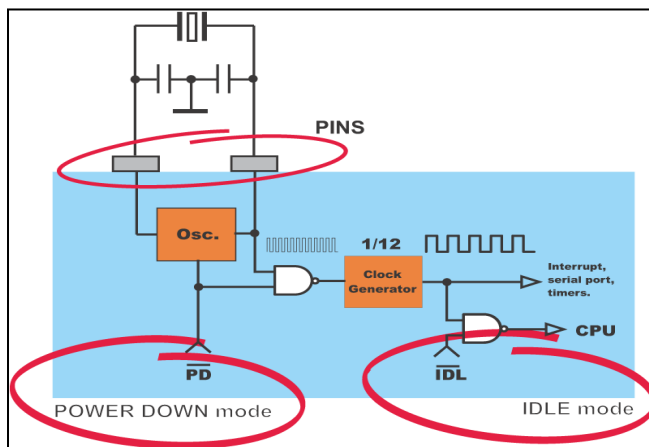
1. Attempt any **FIVE** of the following:

20

a) Describe the power down mode operation in 8051 microcontroller.

(Diagram - 2 Marks, Explanation with PCON – 2 Marks)

Ans:



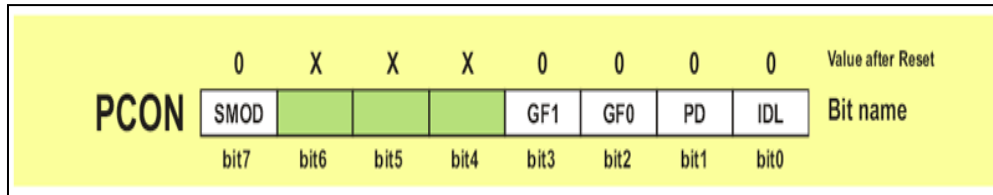


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PCON register



Power Down mode operation:

By setting the PD bit of the PCON register from within the program, the microcontroller is set to Power down mode, thus turning off its internal oscillator and reduces power consumption enormously. The microcontroller can operate using only 2V power supply in power- down mode, while total power consumption is less than 40uA. The only way to get the microcontroller back to normal mode is by reset.

While the microcontroller is in Power Down mode, the state of all SFR registers and I/O ports remains unchanged. By setting it back into the normal mode, the contents of the SFR register is lost, but the content of internal RAM is saved. Reset signal must be long enough, approximately 10mS, to enable stable operation of the quartz oscillator.

- b) **Enlist different Special Function Register (SFR) with their functions and addresses.**
(List – 1 Mark, address - 1 Mark, functions – 2 Marks)

Ans:

1) P0 (Port 0, Address 80h, Bit-Addressable):

Function: This is input/output port 0. Each bit of this SFR corresponds to one of the pins on the microcontroller.

2) SP (Stack Pointer, Address 81h):

Function: This SFR points to the stack top. If you push a value onto the stack, the value will be written to the address of SP + 1.

3) DPL/DPH (Data Pointer Low/High, Addresses 82h/83h):



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Function: The SFRs DPL and DPH work together to represent a 16-bit value called the *Data Pointer*. The data pointer is used in operations regarding external RAM and some instructions involving code memory.

4) PCON (Power Control, Addresses 87h):

Function: The Power Control SFR is used to control the 8051's power saving modes which are power down mode and idle mode control modes. Additionally, one of the bits in PCON is used to double the effective baud rate of the 8051's serial port.

5) TCON (Timer Control, Addresses 88h, Bit-Addressable):

Function: The Timer Control SFR is used to configure and modify the way in which the 8051's two timers operate.

6) TMOD (Timer Mode, Addresses 89h):

Function: The Timer Mode SFR is used to configure four mode of operation of each of the two timers.

7) TL0/TH0 (Timer 0 Low/High, Addresses 8Ah/8Ch):

Function: These two SFRs, taken together, represent timer 0 and are used to store the count .

8) TL1/TH1 (Timer 1 Low/High, Addresses 8Bh/8Dh):

Function: These two SFRs, taken together, represent timer 1 and are used to store the count .

9) P1 (Port 1, Address 90h, Bit-Addressable):

Function: This is input/output port 1. Each bit of this SFR corresponds to one of the pins on the microcontroller. (P1.0 TO P1.7)

10) SCON (Serial Control, Addresses 98h, Bit-Addressable):

Function: The Serial Control SFR is used to configure the behavior of the 8051's on-board serial port. This SFR controls the baud rate of the serial port,



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11) SBUF (Serial Control, Addresses 99h):

Function: The Serial Buffer SFR is used to send and receive data via the on-board serial port, on TXD & RXD respectively

12) P2 (Port 2, Address A0h, Bit-Addressable):

Function: This is input/output port 2. Each bit of this SFR corresponds to one of the pins on the microcontroller. (P2.0/A8 - P2.7/A15)

13) IE (Interrupt Enable, Addresses A8h):

Function: The Interrupt Enable SFR is used to enable and disable specific interrupts of 8051

14) P3 (Port 3, Address B0h, Bit-Addressable):

Function This is input/output port 3. Each bit of this SFR corresponds to one of the pins on the microcontroller. (P3.0 – P3.7) Also every port 3 pin has alternate function

15) IP (Interrupt Priority, Addresses B8h, Bit-Addressable):

Function: The Interrupt Priority SFR is used to assign the relative priority of each interrupt.

16) PSW (Program Status Word, Addresses D0h, Bit-Addressable):

Function: The Program Status Word is used to store a number of important bits that are set and cleared by 8051 instructions. The PSW SFR contains the carry flag, the auxiliary carry flag, the overflow flag, and the parity flag. Additionally, the PSW register contains the register bank select flags which are used to select which of the "R" register banks are currently selected.

17) ACC (Accumulator, Addresses E0h, Bit-Addressable):

Function: The Accumulator is one of the most-used SFRs on the 8051 since it is involved in so many instructions.

18) B (B Register, Addresses F0h, Bit-Addressable):

Function: The "B" register is used in two instructions: the multiply and divide operations. The B register is also commonly used by programmers as an auxiliary register to temporarily store values.



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c) **Explain the following assembler directives giving one example of each:**

- (i) **ORG**
- (ii) **END**
- (iii) **DB**
- (iv) **DW**
- (v) **EQU**

(Each directive explanation - 2 Marks, example – 2 Marks)

Ans:

i) DB:- Data 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.

Syntax:

LABEL: DB BYTE

Example: **DB 0f0h, 0A0h, 90h**

ii) EQU: Equate

It is used to define constant without occupying a memory location.

Syntax:

Name EQU Constant By means of this directive, a numeric value is replaced by a symbol.

Example: **MAXIMUM EQU 99**

After this directive every appearance of the label “MAXIMUM” in the program, the assembler will Interpret as number 99 (MAXIMUM=99).

iii) ORG: Origin

It is used to indicate the beginning of address.

Syntax:

ORG Address

The address can be given in either hex or decimal there should be a space of at least one character between ORG & address fields. Some assemblers use ORG should not begin in label field.

Ex ample **ORG 1000h**

iv) END:

This directive must be at the end of every program. Meaning that in the source code anything after the END directive is ignored by the assembler. This indicates to the assembler the end of the



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source file (asm). Once it encounters this directive, the assembler will stop interpreting program into machine code.

Example END; End of the program.

v) DW directive

The DW directive is similar to the DB directive. It is used for writing a two-byte value into program memory. The higher byte is written first, then the lower one.

d) Explain the syntax for an assembly language instruction.

(NOTE: Any two instructions syntax with function - 2 Marks each)

Ans:

1) Arithmetic Instructions and syntax

a) ADD A,Rn - Adds the register Rn to the accumulator

A: accumulator

Rn: any R registers (R0-R7)

Description: Instruction adds the register Rn (R0-R7) to the accumulator. After addition, the result is stored in the accumulator.

Syntax: ADD A,Rn;

b) ADD A,@Ri - Adds the indirect RAM to the accumulator

A: accumulator

Ri: Register R0 or R1

Description: Instruction adds the indirect RAM to the accumulator. Address of indirect RAM is stored in the Ri register (R0 or R1). After addition, the result is stored in the accumulator.

Syntax: ADD A, @Ri;

(Or any other two arithmetic instructions syntax are also considered)

2) Branch Instructions and syntax (any two instruction syntax)

a) ACALL addr11 - Absolute subroutine call

addr11: Subroutine address



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Description: Instruction unconditionally calls a subroutine located at the specified code address. Therefore, the current address and the address of called subroutine must be within the same 2K byte block of the program memory, starting from the first byte of the instruction following ACALL.

Syntax: ACALL [subroutine name];

b) AJMP addr11 - Absolute jump

addr11: Jump address

Description: Program continues execution after executing a jump to the specified address. Similar to the ACALL instruction, the jump must be executed within the same 2K byte block of program memory starting from the first byte of the instruction following AJMP.

Syntax: AJMP address (label);

(Or any other two branch control instructions syntax are also considered)

3) Data Transfer Instructions (any two instructions)

a) MOV Rn,A - Moves the accumulator to the Rn register

Rn: any R registers (R0-R7)

A: accumulator

Description: Instruction moves the accumulator to the Rn register. The accumulator is not affected.

Syntax: MOV Rn,A;

b) MOV A,#data - Moves the immediate data to the accumulator

A:

accumulator

Data: Constant in the range of 0-255 (0-FFh)

Description: Instruction moves the immediate data to the accumulator.

Syntax: MOV A,#data;

(Or any other two data move instructions syntax are also considered)

4) Logic Instructions (any two instructions)

a) ANL A,direct - AND direct byte to the accumulator

A: accumulator

Direct: arbitrary register with address 0 - 255 (0 - FFh)



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Description: Instruction performs logic AND operation between the accumulator and direct register. As it is direct addressing, the register can be any SFRs or general-purpose register with address 0-7Fh (0-127 dec.). The result is stored in the accumulator.

Syntax: ANL A,direct;

b) ANL A,#data - AND immediate data to the accumulator

A:accumulator

Data: constant in the range of 0-255 (0-FFh)

Description: Instruction performs logic AND operation between the accumulator and data. The result is stored in the accumulator.

Syntax: ANL A,#data;

(Or any other two logical instructions syntax are also considered)

5)Bit-oriented Instructions (any two instructions)

a) CPL bit – Complements the direct bit

Bit: any bit of RAM

Description: Instruction complements the specified bit of RAM (0→1, 1→0).

Syntax: CPL [bit address];

b) CPL C - Complements the carry flag

C: Carry flag

Description: Instruction complements the carry flag (0==>1, 1==>0).

Syntax: CPL C;

(Or any other two bit level instructions syntax are also considered)

- e) Assume XTAL = 12 MHz. Write a program to generate a square wave on P 1.2 pin. Find the lowest frequency that can be generated using mode 1. (ALP or C)**
(Calculation – 2 Marks, program – 2 Marks)

Ans:

Lowest Frequency that can be generated using mode 1 using 12MHz crystal.

- Lowest frequency means highest delay
- Mode 1 i.e 16 bit timer so we can select counter value 0000
- Maximum pulses that can be counted is 0000 to FFFF i.e. 65536
- Timer clock Frequency is = $XTAL / 12 = 12 \text{ MHz} / 12$



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- = 1 MHz
- Timer clock period is = 1/Timer Frequency
= 1 / 1 MHz
= 1 uSec
- Maximum Delay = 1 uSec X 65536
= 65536 uSec
- The maximum delay is the high or low portion of the square wave = 65536uSec
- So total maximum time for square wave is = 2 X Maximum Delay
= 2 X 65536uSec
= 131072 uSec
- Lowest Frequency = 1 / total maximum time for square
= 1/ 131072 uSec
= 7.63HZ

//C language program to generate square wave over Port Pin P1.2 using timer0

```
#include <Intel\8052.h>
#include <standard.h>
Void TOM1delay (void);           //Timer 0, Mode 1(16 bit timer)
SBIT OUTPUT P1^2;               // Initialize Port pin P1.2 as output
Void main ()
{
    While (1)
    {
        OUTPUT= ~ OUTPUT;       // toggle P1.2
        TOM1delay ();           // delay of 50 uSec
    }
}

Void TOM1delay ();              // Timer 0, Mode 1(16 bit timer) - delay of 50 uSec
{
    TMOD= 0x01;                 // Timer 0, Mode 1(16 bit timer)
    TLO = 0x00;                 //Load TLO = 00h
    TH0 = 0x00;                 //Load TLO = 00h
    TR0 = 1;                    //Run the timer 0
    while (TF0 == 0) // Wait for TF0 to overflow
    {
        TR0 = 0;               //Stop the timer 0
        TF0 = 1;               //Clear TF0
    }
}
```



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(NOTE: Program may change but Calculations will not change. Student can also use the other logic. Please check the logic and understanding of students.)

OR

//Assembly language program to generate square wave over Port Pin P1.2 using timer0

```
MOV TMOD,#01H      ; TIMER0 IN MODE1
UP:MOV TL0,# 00H     ;load count TL0
MOV TH0,#00H        ;load countTH0
SETB TR0            ; START TIMER0
BACK: JNB TF0 ,BACK
CPL P1.2            ; generate H TO L
CLR TF0
CLR TR0
SJMP UP
```

f) State four features of embedded systems and state any four applications.

(Any Four Features - 2 Marks, any two application - 2 Marks)

Ans:

Features:

- 1) These are special purpose computer systems built into a larger device.
- 2) Most of these are usually Non User Programmable.
- 3) These systems are produced in Bulk.
- 4) It is less costly because of Bulk Production.
- 5) The devices like Mobile Phones usually work under severe power budget constraints to enhance their Battery life.
- 6) All such systems are usually application specific hence general purpose peripheral interfaces are absent.
- 7) Any Embedded System should have less Memory Requirement.
- 8) Relocation facility of faulty Electronic Memory to some unused good Memory block should exist.
- 9) Usually Hard Timing Constraints are associated for most of it's functions necessitating usage of Real Time System features.
- 10) In general, each & every Embedded System happens to be application specific Uni-Processor system, which is built on a simple hardware architecture platform



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(Applications: any two of the following)

1) Applications of Embedded Systems:

Embedded systems are used in different applications like automobiles, telecommunications, smart cards, missiles, satellites, computer networking and digital consumer electronics.

2) Embedded Systems in Automobiles and in telecommunications

- Motor and cruise control system
- Body or Engine safety
- Entertainment and multimedia in car
- E-Com and Mobile access
- Robotics in assembly line
- Wireless communication
- Mobile computing and networking

3) Embedded Systems in Smart Cards, Missiles and Satellites

- Security systems
- Telephone and banking
- Defense and aerospace
- Communication

4) Embedded Systems in Peripherals & Computer Networking

- Displays and Monitors
- Networking Systems
- Image Processing
- Network cards and printers

5) Embedded Systems in Consumer Electronics

- Digital Cameras
- Set top Boxes
- High Definition TVs
- DVDs



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g) What do you mean by starvation?

(Marks - 4)

Ans:

Starvation:

- a) Multiple shared resources have multiple semaphores associated with them.
- b) The semaphores are all independent of one another. If one task takes semaphore X then another task can take semaphore Y, without blocking.
- c) But this property can lead to deadlock.
- d) For example, suppose task 1 calls function to take semaphore X & get it but before it can call the function to take semaphore Y the RTOS stops the execution of task 1 & runs task 2.
- e) The task2 calls the function to take semaphore & gets it.
- f) But when task2 calls the function to take the semaphore X, it is blocked since, the Task1 has already taken the semaphore X.
- g) The RTOS now switch back to task 1, which now calls the function to take semaphore Y. since task2 has semaphore Y, task 1 is also now blocked.
- h) There is no escape from this for either tasks, since now both are blocked, waiting for semaphores that the other has.
- i) This problem due to multi-tasking is called Starvation, where a task is denied necessary resources repeatedly without those resources the task will never be completed.
- j) Deadlock is a special case of Starvation.

2. Attempt any FOUR of the following:

16

a) Draw the power ON reset circuit of 8051 microcontroller .Give its content of port p₀ –p₃ and SP register on reset.

(Circuit - 2 Marks, Reset value - 2 Marks)

Ans:

RESET is an active High input When RESET is set to High, 8051 goes back to the power on state. The 8051 is reset by holding the RST high for at least **two machine cycles** and then returning it low.



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There are two method of reset circuit:

1) Power on Reset.

- Initially charging of capacitor makes RST High
- When capacitor charges fully it blocks DC.

2) Manual Reset

- Closing the switch momentarily will make RST High.

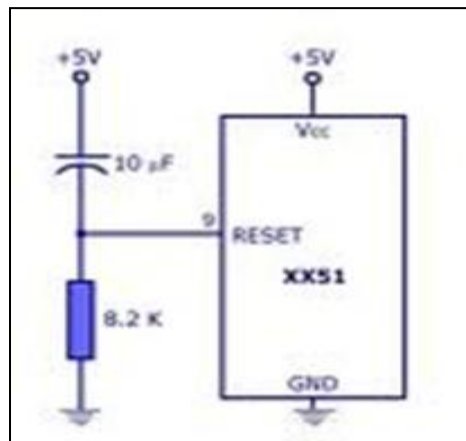


Figure1 power on reset ckts

After a reset, the **program counter is loaded with 0000H** but the content of on-chip RAM is not affected.

Register	contents
Port 0 to port3	FFh
SP	07h



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- b) Write an assembly language program for the 8051 microcontroller to multiply two 8 bit numbers stored at memory location 20 H and 21 H. Store the product at 22 H and 23 H.

(Program - 3 Marks, comments - 1 Mark)

Ans:

```
ORG 000H
MOV A, 20H Get the first number
MOV B, 21H get the second number
MUL AB multiply first number with second number and results goes in A and B
MOV 22H, A store LSB at 22h location
MOV 23H, B store MSB at 23 h location
END stop
```

- c) Indicate which timer and mode is selected for each of the following instructions:

- (i) MOV. TMOD , # 01 H
- (ii) MOV. TMOD , # 12 H

(Each - 2 Marks)

Ans:

- (i) timer 1 in mode 0 and timer0 mode1
- (ii) Timer 1 in mode1 and timer 0 in mode2



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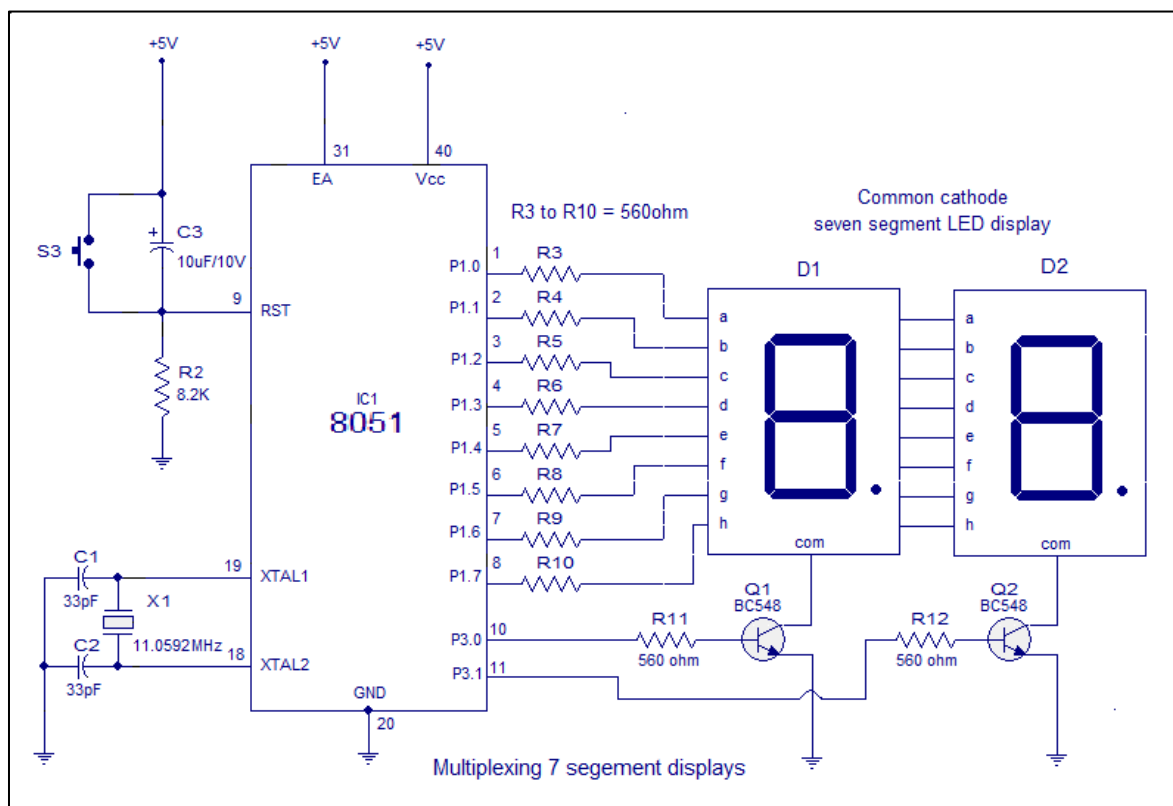
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d) Draw the interfacing of seven segment multiplexed display with 8051 microcontroller.

(Correct diagram - 4 Marks)

Ans:





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e) **State the function of the following :**

- (i) **In Circuit emulator (ICE)**
- (ii) **Integrated Development Environment (IDE)**
- (iii) **Target board**
- (iv) **Device programmer**

(Each - 1 Mark)

Ans:

(i) **In –Circuit Emulator (ICE):-**

- It is a hardware device used to debug the s/w of an embedded system
- It provides a window into the embedded system. The programmer uses the emulator to load programs into the embedded system, run them and view and change data used by the systems s/w.
- It emulates the CPU of the embedded systems computer.

Recent ICEs enable a programmer to access the on chip debug circuit that is integrated into the CPU via JTAG or BDM in order to debug the s/w of an embedded system

(ii) **Integrated Development Environment (IDE) :-**

- It supports for defining a processor family and its version
- Support a user definable assembler to support a new version or a type of processor.
- Provides multiuser environment
- Supports conditional and unconditional break points
- Provide debugger.

(iii) **Target Board :-** It has a processor i.e. microprocessor or microcontroller, memory for image of the embedded s/w i.e. ROM , memory for the implementation of the stack, temporary variables and memory buffers i.e. RAM , peripheral devices and interfaces such as RS 232 , 10/100-base Ethernet, parallel ports, USB port etc.

- It consists microcontroller 8051, Monitor, flash memory, RAM , Serial Ports , parallel ports, system keyboard, system display etc.

(iv) **Device Programmer:-**



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- It is the hardware tool used to burn i.e Load the hex or bin file into Microcontroller.

f) Describe the meaning of deadlock with suitable example.

(Description - 3 Marks, diagram - 1 Mark)

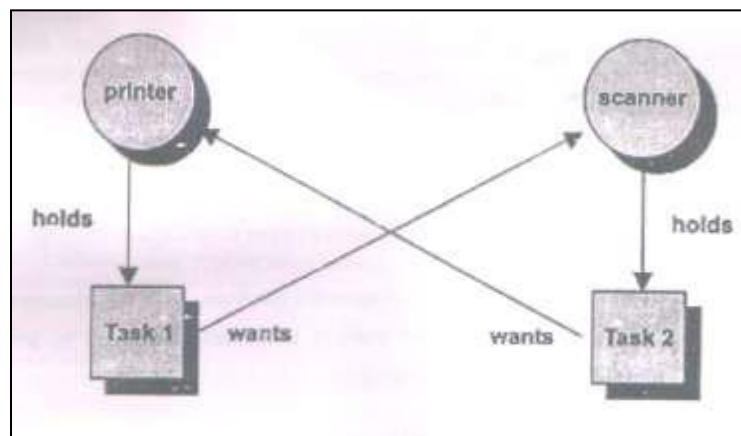
Ans:

Deadlock:

- A deadlock, also called as deadly embrace, is a situation in which two threads are each unknowingly waiting for resource held by other.
- Assume thread T1 has exclusive access to resource R1.
- Thread T2 has exclusive access to resource R2.
- Neither thread can continue.
- They are deadlocked.

The simplest way to avoid a deadlock is for threads to:

- Acquire all resources before proceeding
- Acquire the resources in the same order
- Release the resource in the reverse order
- Deadlock is the situation in which multiple concurrent threads of execution in a system are blocked permanently because of resources requirement that can never be satisfied.
- A typical real-time system has multiple types of resources and multiple concurrent
- Threads of execution contending for these resources. Each thread of execution can acquire multiple resources of various types throughout its lifetime.
- Potential for deadlock exist in a system in which the underlying RTOS permits
- Resources sharing among multiple threads of execution.
- Following is a deadlock situation between two tasks.





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	Marks
3. Attempt any <u>FOUR</u> of the following :	16

- a) **Enlist the ports of 8051 microcontroller and write which port has alternate function.**
(List - 2 Marks, Alternate function - 2 Marks)

Ans:

Ports of 80C51 are-

- a) Port 0
- b) Port 1
- c) Port 2
- d) Port 3

PORT 0 has alternate function – AD0 to AD7

PORT 2 has alternate function – A8 to A15

PORT 3 has Alternate functions – RXD, TXD, INT0, INT1, TO, T1, RD, WR

- b) **Describe the function of the following instructions of 8051:**
- (i) **JZ radd**
 - (ii) **DAA**

(2 Marks for each proper function)

Ans:

1) **JZ radd** - Jump to the relative address if A is 0; the flags and the A register are not changed.
JZ instruction can be used only for register A. It can only check to see whether the accumulator is zero and it does not apply to any other register.

2) **DAA**- Decimal adjust for addition - provided to correct the aforementioned problem associated with BCD addition.

The mnemonic DA has as its operand the accumulator A. The DAA instruction will add 6 to the lower nibble if needed.



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- c) State the interrupts of 8051 microcontrollers in descending order of priority.

(Listing of interrupts -2 Marks, priority - 2 Marks)

Ans:

Interrupts available in 8051 with their priority and vector locations is as shown below

Interrupt	Vector address	Priority
External interrupt 0	0003h	1 Highest
Timer/counter 0	000Bh	2
External interrupt 1	0013h	3
Timer/counter 1	001Bh	4
Serial port	0023h	5 Lowest

- d) Write an assembly language program or C program for rotating stepper motor in clockwise direction continuously using four step sequences.
(Correct program - 4 Marks)

Ans:

```
Main: MOV P1, #0CH
      ACALL DELAY
      MOV P1, #06H
      ACALL DELAY
      MOVP1, #03H
      ACALL DELAY
      MOV P1, # 09H
      ACALL DELAY
      SJMP MAIN
      DELAY:
```



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```
MOV R7, #4
WAIT2:
MOV R6, #0FFH
WAIT1: MOV R5, #0FFH
WAIT:
DJNZ R5, WAIT
DJNZ R6, WAIT1
DJNZ R7, WAIT2
RET
```

C LANGUAGE

```
#include<REG2051.H>
#define stepper P1
void delay();
void main()
{
While(1)
{ stepper = 0x0C;
delay();
Stepper = 0x06;
delay();
stepper = 0x03;
delay();
stepper = 0x09;
delay();
}
}
void delay()
{
Unsigned char i,j,k;
for(i=0;i<6;i++)
for(j=0;j<255;j++)
for (k=0;k<255;k++)
}
```



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(students can use any other program logic, correct logic should be given marks)

e) **State any four salient features of an embedded system.**

(Salient feature any 4 – 4 Marks)

Ans:

- 1) Embedded systems are designed to do some specific task, rather than be a general-purpose computer for multiple tasks. Some also have real-time performance constraints that must be met, for reasons such as safety and usability; others may have low or no performance requirements, allowing the system hardware to be simplified to reduce costs.
- 2) Embedded systems are not always standalone devices. Many embedded systems consist of small, computerized parts within a larger device that serves a more general purpose. For example, the Gibson Robot Guitar features an embedded system for tuning the strings, but the overall purpose of the Robot Guitar is, of course, to play music similarly, an embedded system in an automobile provides a specific function as a subsystem of the car itself.
- 3) The program instructions written for embedded systems are referred to as firmware, and are stored in read-only memory or Flash memory chips. They run with limited computer hardware resources: little memory, small or non-existent keyboard and/or screen.
- 4) **Size & Weight:** Microcontrollers are designed to deliver maximum performance for minimum size and weight. A centralized on-board computer system would greatly outweigh a collection of microcontrollers.
- 5) **Efficiency:** Microcontrollers are designed to perform repeated functions for long periods of time without failing or requiring service. Other computer systems are prone to software and hardware failure as well as a whole host of other problems recognizable to the users of any home computer. Above all other considerations, computer systems must be 100% reliable when trusted to control such functions as braking in an automobile.



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- f) **Describe Hard real time and Soft real time systems in an embedded system with one suitable example of each.**

(Hard real time system - 2 Marks, soft real time system - 2 Marks)

Ans:

Hard real time system: A hard real time system also known as immediate real time system. It is hardware or software that must operate within the confines of stringent deadline. The application may be considered to have failed if it does not complete its function within the allotted time span. Eg. Components of pacemakers, anti-lock brakes and aircraft control systems.

Soft real time system: A soft real time system where a critical real time task gets priority over other tasks and retains that priority until it completes. As in hard real time systems kernel delays need to be bounded.

Eg. Desktop audio and video, virtual reality, internet telephony, any system with timeless concerns.

4. **Attempt any FOUR of the following :**

16

- a. **Draw architecture of 8051 microcontroller.**
(Neat labelled diagram - 4 Marks)

Ans:

- **Architecture of 8051: (NOTE:- Architecture may vary)**

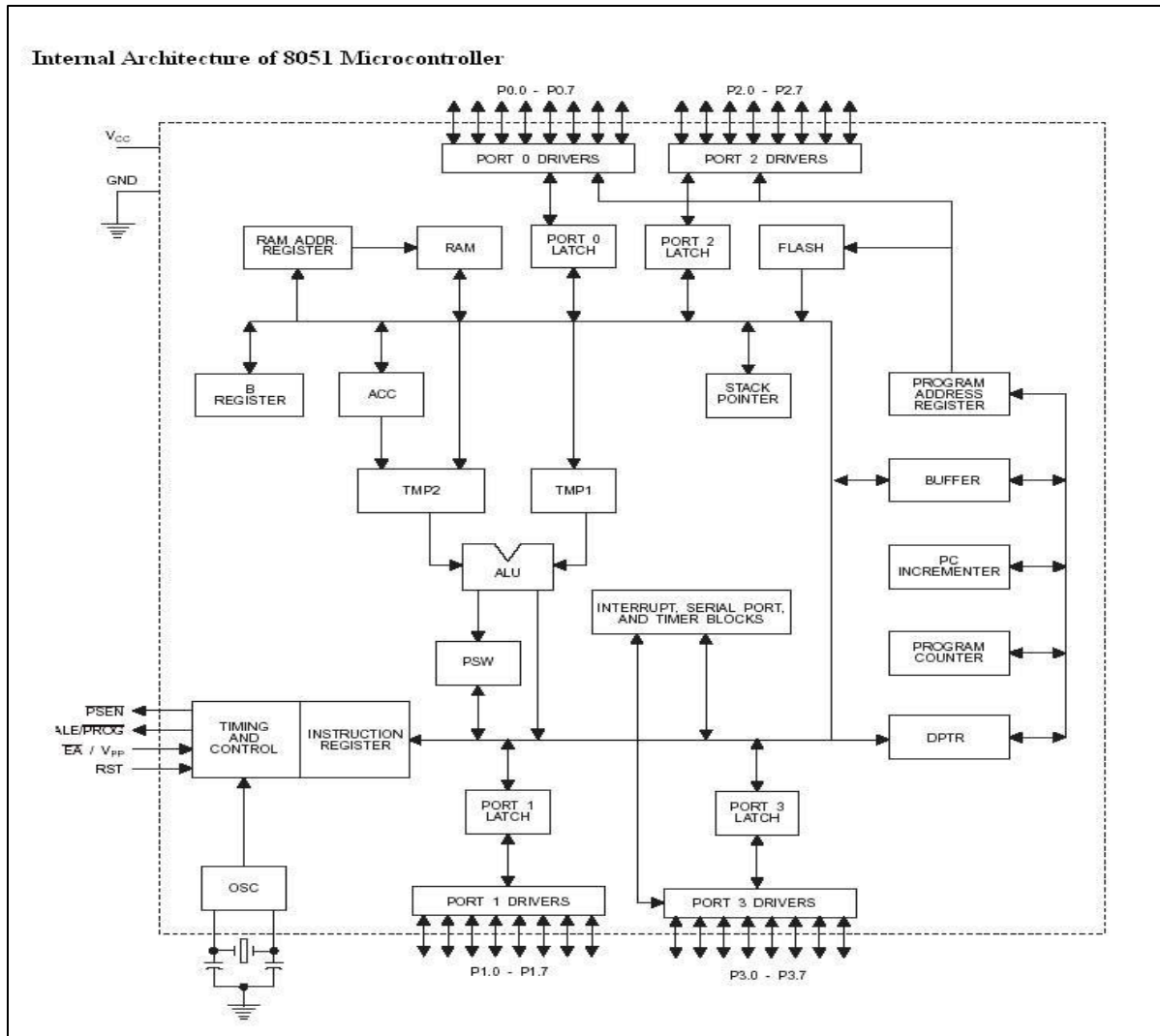


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Architecture ONE



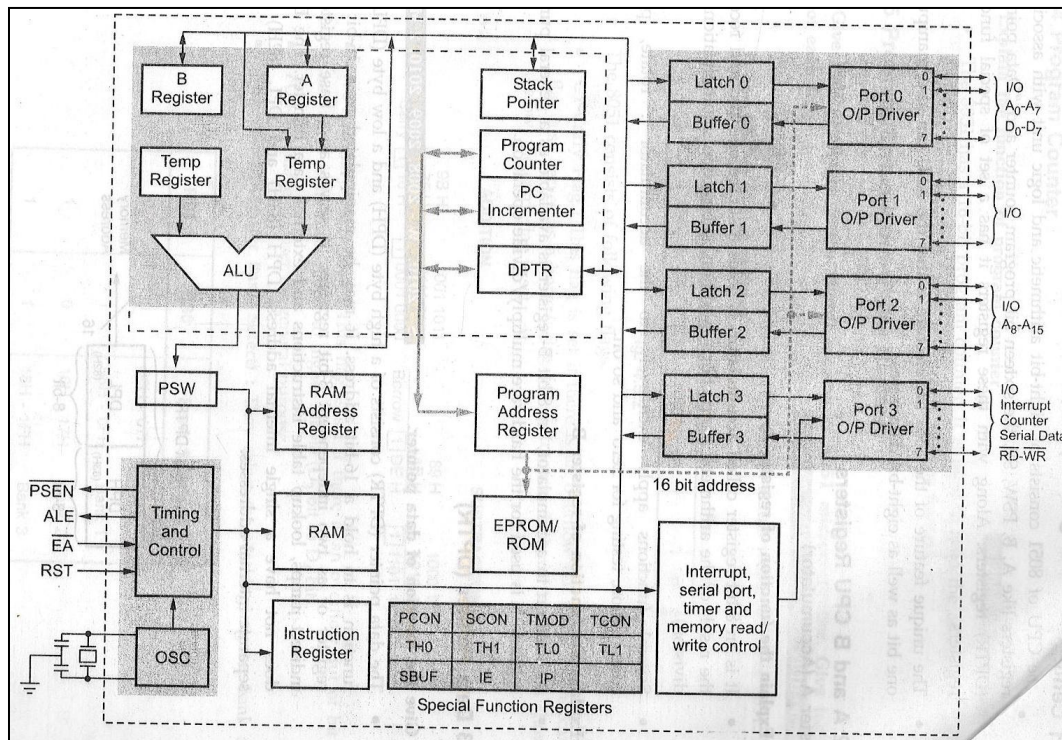


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Architecture TWO



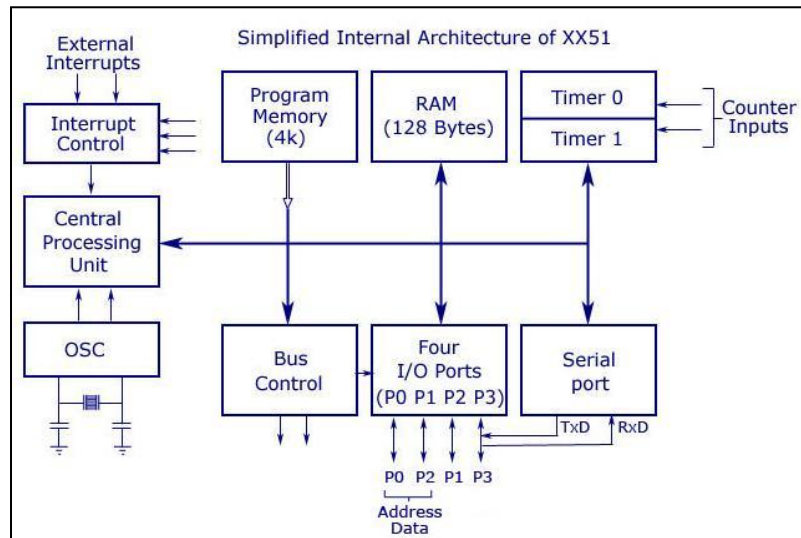


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Architecture THREE



- b. Write a program to unpack the 8 bit number using 8051 microcontroller instructions using C or assembly language
(Correct Program – 4 Marks)

Ans:

MOV A, #8 bit no	; TAKE 8 BIT NO.
MOV R2, A	; SAVE IT TEMPORARY
ANL A, #0FH	; MASK MSB
MOV R6, A	; SAVE UNPACK LSB IN R6
MOV A, R2	; TAKE 8 BIT NO AGAIN
ANL A, #0F0H	; MASK LSB
SWAP A	; SWAP NIBBLES
MOV R2, A	; SAVE MSB IN R2
END	



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C PROGRAM

```
#include <reg51.h>
Void main (void)
{
    Unsigned char x, y, z;
    Unsigned char mybyte = 0x29;
    x= mybyte& 0x0F;
    y = mybyte& 0xF0;
    y = y>>4;
}
```

(students can use any other program logic, correct logic should be given marks)

c. What is serial interface? Explain interrupts present in microcontroller 8051.

(Serial interface explanation - 2 Marks, interrupts explanation - 2 Marks)

Ans:

Serial interface:

Data being transferred between one location and another travel along the 8-bit data bus, because of this data bus, data bytes can be moved about the microcontroller at high speed. Serial interface has the advantage of requiring only one line for the data, a second line for ground and possibly a third line for the clock.

Interrupts in the 8051

1. Reset. When the reset pin is activated, the 8051 jump to address location 0000.
2. Two interrupts are set aside for the timers: one for timer 0 and one for timer 1. Memory location 000BH and 001BH in the interrupt vector table belong to timer 0 and timer1, respectively.
3. Two interrupts are set aside for hardware external hardware interrupts. Pin numbers 12(P3.2) and 13(P3.3) in port 3 are for the external hardware interrupts INT0 and INT1, respectively.



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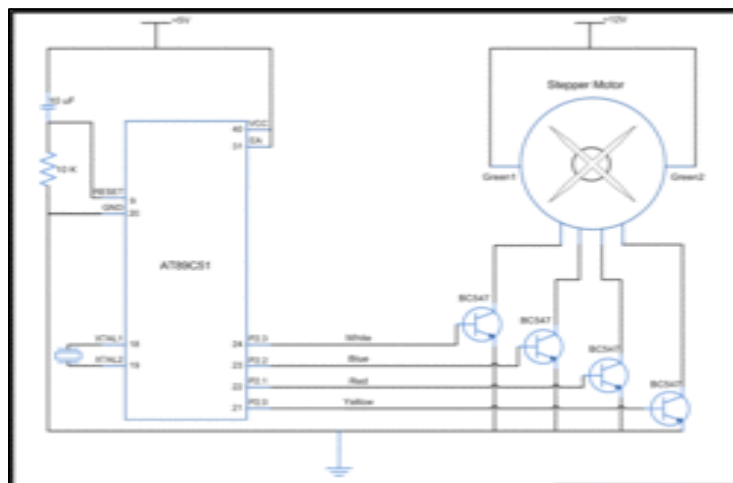
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These external interrupts are also referred to as EX1 and EX2. Memory locations 003H and 0013H in the interrupt vector table are assigned to INT0 and INT1, respectively.

4. Serial communication has a single interrupt that belongs to both receive and transmit. The interrupt vector table locations 0023H belongs to this interrupt.

- d. **Draw labeled diagram of stepper motor connections to 8051 microcontroller. State two specifications of stepper motor.**
(Diagram - 2 Marks, Any two Specifications - 2 Marks, Any other correct diagram can also be given marks)

Ans:



1) Step angle:

1. Step angle of the stepper motor is defined as the angle traversed by the motor in one step.
2. To calculate step angle, simply divide 360 by number of steps a motor takes to complete one revolution.
3. Stepper motor rotating in full mode takes 4 steps to complete a revolution, so step angle can be calculated as...
$$\text{Step Angle } \phi = 360^\circ / 4 = 90^\circ$$
4. In case of half mode step angle gets half, so it is 45°

2) Step Sequencing:



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The step angle is the minimum degree of rotation in single steps. The various stepper motor have the different step angles such as 0.9° , 1.8° , 2.0° , 2.5° , etc., depending on the applications.

For rotation of stepper motor, need to energize coil in sequence.

Stepper motor rotate in two different sequence

- 1) Full step sequence
- 2) Half step sequence

- e. **State two features of simulator and two features of Integrated Development Environment (IDE).**
(*Simulator - 2 Marks, IDE - 2 Marks*)

Ans:

Simulator:

- 1) Is the software that simulates a hardware unit like emulator peripheral, network and input/Output devices on a personal computer and remains independent of particular target machine.
- 2) It is usable during the development phase for the application software for the system that is expected to employ a particular processor or processing device chip.
- 3) Simulator uses cross compiler, linker and locator like the actual target system.
- 4) A simulator helps in the development of the system before the final target of the system is ready with only a PC as the tool for development and readily available for different processors and processing device employing embedded system.

IDE:

1. An integrated development environment (IDE) is a software application that provides comprehensive facilities to computer programmers for software development.
2. An IDE normally consists of a project manager, source code editor, build automation tools and a debugger.
3. Some IDEs contain a compiler, interpreter, or both.
4. Example: keil μ Vision IDE
5. Integrated development environments are designed to maximize programmer productivity by providing a single program in which all development is done.
6. This program typically provides many features for authoring, modifying, compiling, deploying and debugging software.



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- f. Describe the concept of inter process communication in Real Time Operating System (RTOS)**
(Correct answer - 4 Marks)

Ans:

Inter-process communication is the set of techniques for exchanging the data among multiple threads in one or more processes. Inter-process communication techniques are divided into methods for message passing, synchronization, shared memory and remote procedure calls. The method of IPC may vary based on bandwidth and latency of communication between the threads, and the type of data being communicated. IPC methods are as follows:

1. Message Queue
2. Pipeline
3. Remote procedure call
4. Semaphore
5. Signal

Working of Interprocess communication

Example for Signal for other process to start using semaphore (as token, mutex) or Counting semaphores for the inter task communication between tasks sharing a common Buffer.

Consider two tasks of a mobile phone device

A mobile phone device Update_Time task

A task, Task_Display for a multi-line display of outputs which displays current Time on last line.

When the multi-line display task finishes the display of the last but one

Line, an IPC semaphore supdateTD from the display task is posted and the kernel takes Note of it. The task — continuously updating time — then takes the supdateTD



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Marks

5. Attempt any FOUR of the following : **16**

- a) **Explain why 8051 microcontroller is provided with a frequency of 11.0592 MHz on odd value.**

(Explanation - 3 Marks, Baud rate equation - 1 Mark.)

Ans:

The maximum frequency used for microcontroller is up to 24MHz. But 11.0592 MHz crystals are often used because it can be divided to give you exact clock rates for most of the common baud rates for the UART, especially for the higher speeds (9600, 19200).

When Timer 1 is used as the baud rate generator, the baud rates in Modes 1 and 3 are determined by the Timer 1 overflow rate and the value of SMOD (PCON.7 - double speed baud rates).

The baud rate is given by:
$$\frac{2^{\text{SMOD}}}{32} \times \frac{\text{Oscillator Frequency}}{12 \times [256 - (\text{TH1})]}$$

Some typical baud rates for an Oscillator Frequency 11.0592 crystal:

Baud rate	SMOD	TH1
19200	1	0FDH
9600	0	0FDH
4800	0	0FAH
2400	0	0F4H
1200	0	0E8H
300	0	0A0H



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- b) Write an assembly language program to count number of 1's In a byte stored in register B. Store the count of Ram location 10 H.

(Correct Program - 4 Marks)

Ans:

- Program to count number of 1's in a byte

Lable	Instruction	Comments
	ORG 0000H	;Start the program from 0000h location
	MOV R7,#08H	; Take counter 8 for byte number i.e. 8 bit
	MOV R0,#00H	; Use R0 to store number of 1's in 1
	MOV A,B	; Take the byte from register B to Accumulator
NEXT_BIT:	RLC A	; rotate number of ACC in to Carry
	JNC DOWN	; Jump if no CY i.e. jump if no 1's
	INC R0	; Increment R0, if CY=1 i.e number has 1's
DOWN:	DJNZ R7,NEXT_BIT	; Decrement counter i.e R7
	MOV 10H, R0	; Save the result at internal RAM 10H
HERE:	SJMP HERE	; Terminate the program

NOTE: Student may use other logic, please understand the logic and check the program.



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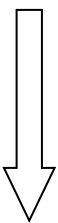
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- c) State the priorities of 8051 microcontroller interrupts if interrupt priority (IP) register = 1AH.

(Correct priorities - 4 Marks)

Ans:

IP Register = 1AH							
D7	D6	D5	D4	D3	D2	D1	D0
--	--	PT2	PS	PT1	PX1	PT0	PX0
0	0	0	1	1	0	1	0

	Highest Priority	=	PT0	=	Timer 0 overflow flag i.e TF0
		=	PT1	=	Timer 1 overflow flag i.e TF1
		=	PS	=	Serial Communication interrupt i.e. RI and TI
		=	PX0	=	External interrupt 0 i.e. INT0
	Lowest Priority	=	PX1	=	External interrupt 1 i.e. INT1



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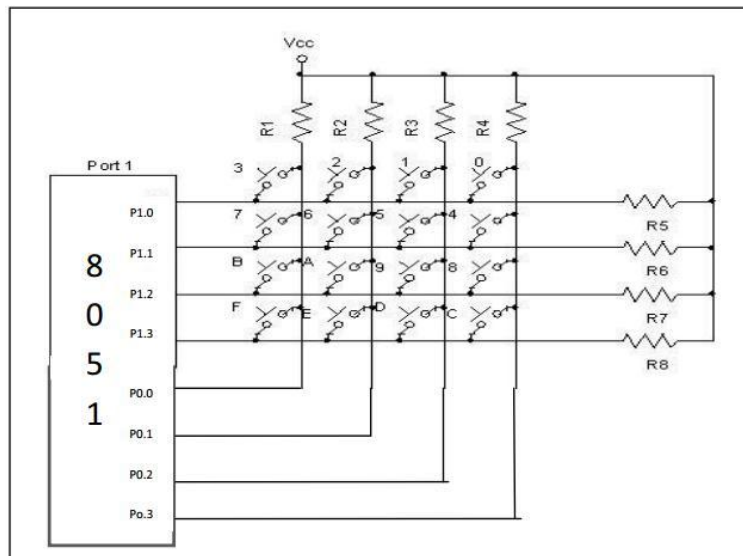
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d) Draw the circuit diagram to interface matrix keyboard with 8051 microcontroller.

(Interfacing Diagram - 4 Marks)

Ans:



Circuit Diagram

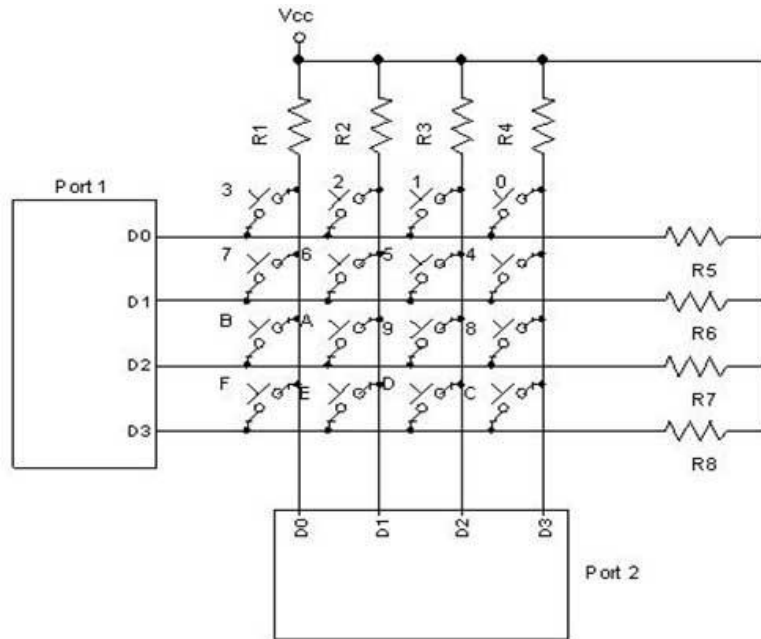


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OR



OR

any other equivalent circuit.



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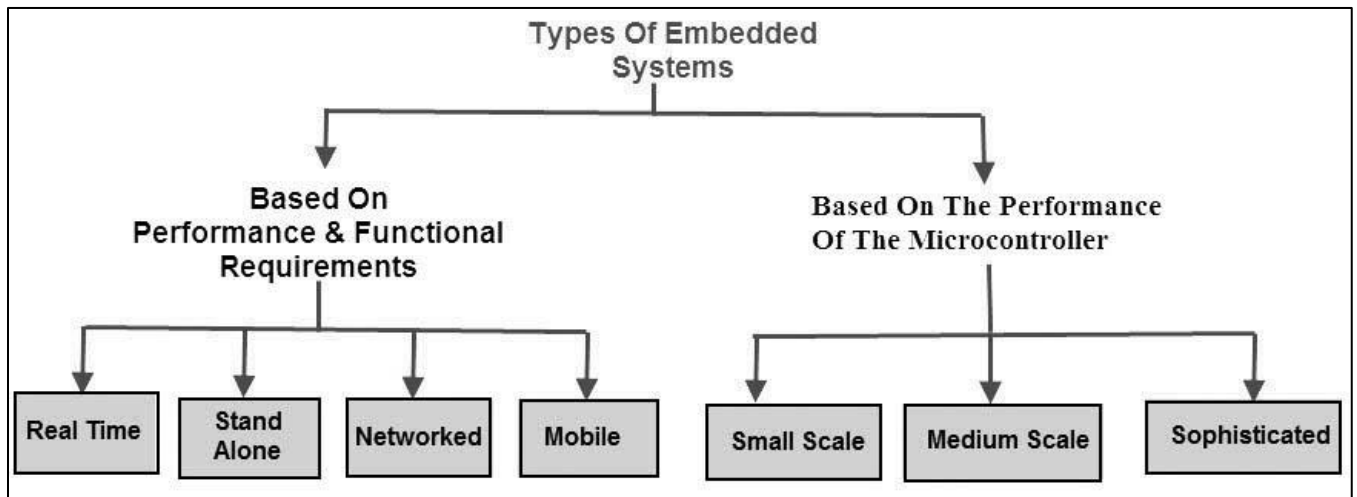
Subject Name: Embedded Systems

e) Give the classification of embedded system in brief.

(Classification - 2 Marks, Brief explanation - 2 Marks)

Ans:

Classification of Embedded System:



Brief explanation:

a. Real Time Embedded Systems

A real time embedded system is defined as, a system which gives a required o/p in a particular time. These types of embedded systems follow the time deadlines for completion of a task. Real time embedded systems are classified into two types such as soft and hard real time systems.

b. Stand Alone Embedded Systems

Stand-alone embedded systems do not require a host system like a computer, it works by itself. It takes the input from the input ports either analog or digital and processes, calculates and converts the data and gives the resulting data through the connected device-Which either controls, drives or displays the connected devices. Examples for the stand alone embedded systems are mp3 players, digital cameras, video game consoles, microwave ovens and temperature measurement systems.



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c. Networked Embedded Systems

These types of embedded systems are related to a network to access the resources. The connected network can be LAN, WAN or the internet. The connection can be any wired or wireless. This type of embedded system is the fastest growing area in embedded system applications. The embedded web server is a type of system wherein all embedded devices are connected to a web server and accessed and controlled by a web browser. Example for the LAN networked embedded system is a home security system wherein all sensors are connected and run on the protocol TCP/IP

d. Mobile Embedded Systems

Mobile embedded systems are used in portable embedded devices like cell phones, mobiles, digital cameras, mp3 players and personal digital assistants, etc. The basic limitation of these devices is the other resources and limitation of memory.

e. Small Scale Embedded Systems

These types of embedded systems are designed with a single 8 or 16-bit microcontroller that may even be activated by a battery. For developing embedded software for small scale embedded systems, the main programming tools are an editor, assembler, cross assembler and integrated development environment (IDE).

f. Medium Scale Embedded Systems

These types of embedded systems design with a single or 16 or 32 bit microcontroller, RISCs or DSPs. These types of embedded systems have both hardware and software complexities. For developing embedded software for medium scale embedded systems, the main programming tools are C, C++, and JAVA, Visual C++, and RTOS, debugger, source code engineering tool, simulator and IDE.

g. Sophisticated Embedded Systems

These types of embedded systems have enormous hardware and software complexities, that may need ASIPs, IPs, PLAs, scalable or configurable processors. They are used for cutting edge applications that need hardware and software Co-design and components which have to assemble in the final system.



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f) Describe the concept of Multitasking in Real Time Operating System (RTOS)

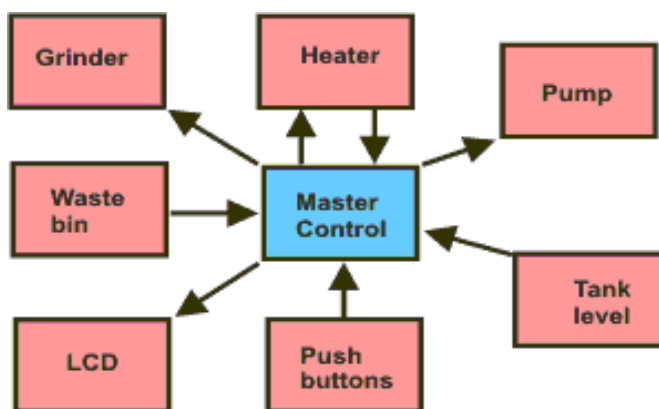
(Concept of Multitasking with any one example - 4 Marks)

Ans:

Multitasking concept in Real Time Operating System (RTOS):

Multitasking is a concept of performing multiple tasks (also known as processes) over a certain period of time by executing them concurrently. Embedded system are generally specific but need to perform many task for same application let us consider example of grinding control machine A simple microcontroller program can only do one thing at a time. However, because it can do things very fast (millions of operations per second), it can be made to switch between tasks so fast that it gives an illusion of doing several things concurrently. The question is, how do you program it so it will divide its attention between multiple tasks, Round robin and round robin with interrupts are ways to achieves the multitasking Imagine now a program with 25 steps in the main function plus 5 sub-functions (heating water, updating the display, watching 3 push buttons). Suppose some of those sub-functions also contain a number of steps with delays. Very, very quickly the complexity of the program becomes quite impossible to untangle.

Example: Grinding control unit



[Note: Any other example will do.]



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6. Attempt any **FOUR** of the following :

16

a) Describe the functions of port 1 of 8051 microcontroller and also draw the structure of port 1.

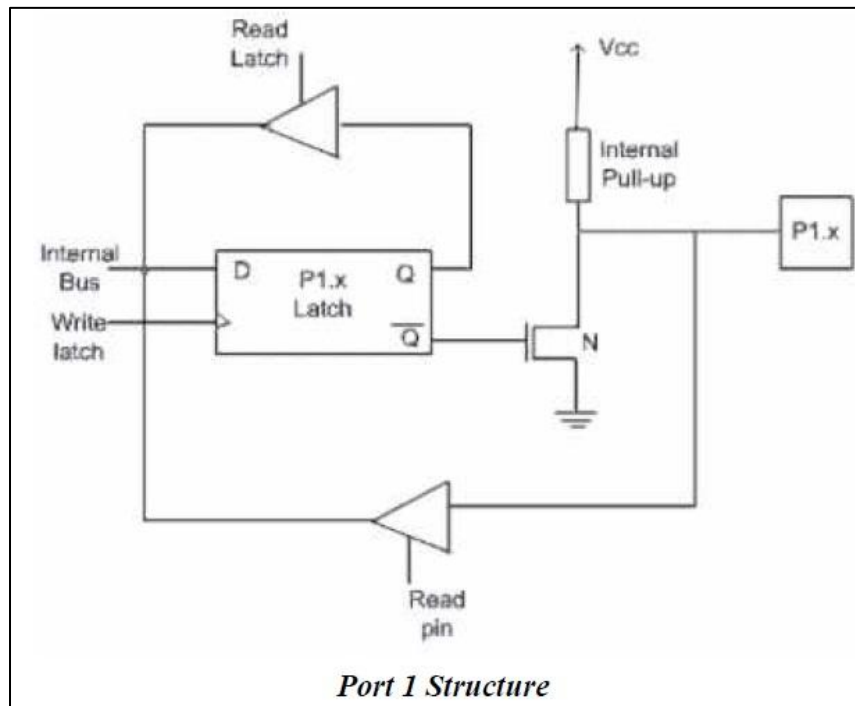
(PORT 1 Function - 2 Marks, Port 1 Structure diagram - 2 Marks.)

Ans:

PORT 1 Function:

- PORT 1 is dedicated INPUT – OUTPUT Port.
- It doesn't have any alternate function.
- PORT 1's bits i.e. P1.0 to P1.7 are bidirectional
- PORT 1 is bit assessable.

PORT 1 structure:





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- b) Write instructions to divide R_4 by R_3 and store quotient and remainder from 5000H external RAM.

(Correct Program - 4 Marks)

Ans:

Lable	Instruction	Comments
	MOV DPTR,#5000H	; Load external memory address in DPTR
	MOV A,R4	;Take first number from R4 in to ACC
	MOV B,R3	;Take second number from R3 in to B
	DIV AB	; Divide A by B
	MOVX @DPTR, A	; Store the quotient at DPTR i.e 5000H
	INC DPTR	; Increment DPTR i.e DPTR becomes 5001H
	MOV A,B	; load the remainder into ACC from B
	MOVX @DPTR, A	; Store the reminder at DPTR i.e 5001H
HERE:	SJMP HERE	;Terminate the program



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- c) Give data of interrupt priority (IP) register to assign priorities as under:
- (i) Highest priority to *INT1*
 - (ii) Highest to timer 0 and next to serial port.

(Each - 2 Marks)

Ans:

- (i) Data of IP register to assign Highest Priority to *INT1*:

IP Register							
D7	D6	D5	D4	D3	D2	D1	D0
--	--	PT2	PS	PT1	PX1	PT0	PX0
0	0	0	0	0	1	0	0

Data of IP register to assign Highest Priority to *INT1* is = 04H

- (ii) Data of IP register to assign Highest to timer 0 and next serial port.

IP Register							
D7	D6	D5	D4	D3	D2	D1	D0
--	--	PT2	PS	PT1	PX1	PT0	PX0
0	0	0	1	0	0	1	0

Data of IP register to assign Highest to timer 0 and next serial port is = 12H



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- d) Write an assembly language program to interface DAC with 8051 microcontroller and to generate a triangular wave.
(Correct Program - 4 Marks)

Ans:

Program to generate triangular wave using DAC

Lable	Instruction	Comments
	ORG 0000H	;Start the program from 0000h location
REPEAT:	MOV A,#00H	; Take lower value i.e.00 for positive slop
UP1:	MOV P1,A	; transfer ACC content to P1 i.e. DAC
	INC A	; Increment ACC
	CJNE A,#0FFH,UP1	; Compare ACC with maximum, if it is not maximum jump to UP1
	MOV A,#0FFH	; Take maximum value i.e. FFH for negative slop
UP2:	MOV P1,A	; transfer ACC content to P1 i.e. DAC
	DEC A	; Decrement ACC
	CJNE A,#00H,UP2	; Compare ACC with minimum, if it is not Minimum then jump to UP2
	SJMP REPEAT	;Repeat the process from +Ve slop.



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e) **With suitable example describe the concept of device driver.**

(Concept of device driver - 3 Marks, Any Example - 1 Mark)

Ans:

Concept of Device driver:

- A device driver is a software routine, allowing a higher level computer program to interact with a hardware device.
- The device driver has software routines that provide the functionality of an input / output I/O device.
- The driver communicates with the device through the computer bus or subsystem. The driver issues commands to the device when a driver routine is invoked.
- The device then sends the data back to the driver, for the driver to invoked routine in the calling program if required.
- Drivers are hardware dependant and operating system specific. A device driver simplifies programming by acting as a layer between the device and the operating system or the application program.
- Any system which has devices will need device drivers, therefore the embedded software programmer must design codes for
 - Device Initialization
 - Device activation
 - Device driving using interrupt service routine
 - Resetting or device deactivation

(Student can give any example)

Example:



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Coffee vending machine

- Device collects coin at input port.
- The system now awakens and activates on interrupt to execute a service routine.
- This is the device driver routine for that input port.

f) Describe soft real time systems in an embedded system with one suitable example.

(Description - 2 Marks, example - 2 Marks)

Ans:

Soft real time system in embedded system

- The term “soft” indicates that there is some flexibility in the real-time requirement.
- Soft real time means that only the priorities and sequence for the task operations are defined, interrupt latencies and context switching latencies are small but there can be few deviations between expected latencies of the tasks and observed time constraints and a few deadline misses are accepted
- The preemption period for the soft real time task in worst case may be about a few ms.
- For a Soft real-time system, even if the system fails to meet the deadline, possibly more than once (i.e. for multiple requests), the system is not considered to have failed.

Example of Soft real time system in embedded system:

Mobile phone, digital cameras and orchestra playing robots are an example of soft real time systems. Android phone is an electronic device whose goal is to operate in real time. When you browse for an appointment or phone number, you expect the device to respond to your finger gestures in a timely manner. However, if a particular gesture requires several seconds to respond rather than the fraction of a second normally required, nothing catastrophic will occur. You may be a little annoyed but you'll assume something important is going on behind the scenes. Perhaps you'll shut down some apps that might be stealing computational power in the background. This type of device is an example of a “soft real-time” embedded device.