JEPPIAAR
ENGINEERING COLLEGE

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

ET3491-EMBEDDED SYSTEMS AND IOT DESIGN

QUESTION BANK

Batch: (2022 – 2026)

Year/ Semester: III/VI

ET3491 **EMBEDDED SYSTEMS AND IOT DESIGN** **L T P C**
3 0 2 4

COURSE OBJECTIVES :

- Learn the architecture and features of 8051.
- Study the design process of an embedded system.
- Understand the real – time processing in an embedded system.
- Learn the architecture and design flow of IoT.
- Build an IoT based system.

UNIT I 8051 MICROCONTROLLER **9**

Microcontrollers for an Embedded System – 8051 – Architecture – Addressing Modes – Instruction Set – Program and Data Memory – Stacks – Interrupts – Timers/Counters – Serial Ports – Programming.

UNIT II EMBEDDED SYSTEMS **9**

Embedded System Design Process – Model Train Controller – ARM Processor – Instruction Set Preliminaries – CPU – Programming Input and Output – Supervisor Mode – Exceptions and Trap – Models for programs – Assembly, Linking and Loading – Compilation Techniques – Program Level Performance Analysis.

UNIT III PROCESSES AND OPERATING SYSTEMS **9**

Structure of a real – time system – Task Assignment and Scheduling – Multiple Tasks and Multiple Processes – Multirate Systems – Pre emptive real – time Operating systems – Priority based scheduling – Interprocess Communication Mechanisms – Distributed Embedded Systems – MPSoCs and Shared Memory Multiprocessors – Design Example – Audio Player, Engine Control Unit and Video Accelerator.

UNIT IV IOT ARCHITECTURE AND PROTOCOLS **9**

Internet – of – Things – Physical Design, Logical Design – IoT Enabling Technologies – Domain Specific IoTs – IoT and M2M – IoT System Management with NETCONF – YANG – IoT Platform Design – Methodology – IoT Reference Model – Domain Model – Communication Model – IoT Reference Architecture – IoT Protocols - MQTT, XMPP, Modbus, CANBUS and BACNet.

UNIT V IOT SYSTEM DESIGN **9**

Basic building blocks of an IoT device – Raspberry Pi – Board – Linux on Raspberry Pi – Interfaces – Programming with Python – Case Studies: Home Automation, Smart Cities, Environment and Agriculture.

45 PERIODS

PRACTICAL EXERCISES **30 PERIODS**

Experiments using 8051.

1. Programming Arithmetic and Logical Operations in 8051.
2. Generation of Square waveform using 8051.
3. Programming using On – Chip ports in 8051.
4. Programming using Serial Ports in 8051.
5. Design of a Digital Clock using Timers/Counters in 8051.

Experiments using ARM

Interfacing ADC and DAC

Blinking of LEDs and LCD

Interfacing keyboard and Stepper Motor.
Miniprojects for IoT
Garbage Segregator and Bin Level Indicator
Colour based Product Sorting
Image Processing based Fire Detection
Vehicle Number Plate Detection
Smart Lock System

TOTAL: 60 PERIODS

COURSE OUTCOMES:

CO1: Explain the architecture and features of 8051.
CO2: Develop a model of an embedded system.
CO3: List the concepts of real time operating systems.
CO4: Learn the architecture and protocols of IoT.
CO5: Design an IoT based system for any application.

TEXTBOOKS :

1. Mohammed Ali Mazidi, Janice Gillispie Mazidi, Rolin D.McKinlay, The 8051 Microcontroller and Embedded Systems Using Assembly and C, Second Edition, Pearson Education, 2008.(Unit – I)
2. 2.Marilyn Wolf, Computers as Components – Principles of Embedded Computing System Design, Third Edition, Morgan Kaufmann, 2012.(Unit – II,III)
3. Arshdeep Bahga, Vijay Madisetti, Internet – of- Things – A Hands on Approach, Universities Press, 2015.(Unit – IV,V)

REFERENCES :

1. Mayur Ramgir, Internet – of – Things, Architecture, Implementation and Security, First Edition, Pearson Education, 2020.
2. Lyla B.Das, Embedded Systems: An Integrated Approach, Pearson Education 2013.
3. Jane.W.S .Liu, Real – Time Systems, Pearson Education, 2003.

CO's-PO's & PSO's MAPPING

C	PO	PO	PO	PO	PO	PO	PO	PO	PO	PO1	PO1	PO1	PSO	PSO	PSO
1	3	3	3	2	2	-	-	-	-	-	-	-	3	2	1
2	3	3	3	2	2	-	-	-	-	-	-	-	3	2	1
3	3	3	2	2	2	-	-	-	-	-	-	-	2	1	1
4	3	3	2	2	2	-	-	-	-	-	-	-	3	3	2
5	3	3	3	3	3	-	-	-	-	-	-	-	3	3	2
C	**3**	**3**	**2.6**	**2.2**	**2.2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2.8**	**2.2**	**1.4**

1 - low, 2 - medium, 3 - high, '-' - no correlation

Vision of the Institute	To build Jeppiaar Engineering College as an institution of academic excellence in technological and management education to become a world class University	
Mission of the Institute	**M1**	To excel in teaching and learning, research and innovation by promoting the principles of scientific analysis and creative thinking
	M2	To participate in the production, development and dissemination of knowledge and interact with national and international communities.
	M3	To equip students with values, ethics and life skills needed to enrich their lives and enable them to meaningfully contribute to the progress of society
	M4	To prepare students for higher studies and lifelong learning, enrich them with the practical and entrepreneurial skills necessary to excel as future professionals and contribute to Nation's economy
Vision of the Department	To become a center of excellence to provide quality education and produce creative engineers in the field of Electronics and Communication Engineering to excel at international level.	
Mission of the Department	**M1**	Inculcate creative thinking and zeal for research to excel in teaching-learning process
	M2	Create and disseminate technical knowledge in collaboration with industries
	M3	Provide ethical and value based education by promoting activities for the betterment of the society
	M4	Encourage higher studies, employability skills, entrepreneurship and research to produce efficient professionals thereby adding value to the nation's economy
Program Specific Outcomes	**After the successful completion of B.E Programme in Electronics and Communication Engineering ,the graduates will be able to**	
PSO I	Design, develop and analyze electronic systems through application of relevant electronics, mathematics and engineering principles.	
PSO II	Design, develop and analyze communication systems through application of fundamentals from communication principles, signal processing, and RF System Design & Electromagnetics.	
PSO III	Adapt to emerging electronics and communication technologies and develop innovative solutions for existing and newer problems	
PEO No.	**Program Educational Objectives Statements**	
PEO I	Produce technically competent graduates with a solid foundation in the field of Electronics and Communication Engineering with the ability to analyze, design, develop, and implement electronic systems.	
PEO II	Motivate the students for successful career choices in both public and private sectors by imparting professional development activities.	
PEO III	Inculcate in the students' ethical values, effective communication skills and develop the ability to integrate engineering skills to broader social needs	
PEO IV	Impart professional competence, desire for lifelong learning and leadership skills in the field of Electronics and Communication Engineering	

UNIT I-8051 MICROCONTROLLERS

TWO MARKS

1 **Discuss the salient features of 8051 family of controllers?**

Eight-bit CPU with registers A (the accumulator) and B.
Sixteen-bit program counter (PC)
Data pointer (DPTR).
Eight-bit program status word (PSW)
Eight-bit stack pointer (SP).
Internal ROM or EPROM (4 KB)Internal
RAM (128 bytes)

1. Four register banks (each 8 registers)
2. 16 bytes, which may be addressed at bit level
3. Eighty bits of general purpose data memoryTwo

16-bit timer / counters: T0 & T1
Full duplex serial data receivers / transmitter (SBUF) Control registers: TCON, TMOD, SCON, PCON, IP and IE.

2 **What is the size of RAM in 8051?**

The size of the RAM is 128 bytes

1. Four register banks (each 8 registers)
2. 16 bytes, which may be addressed at bit level
3. Eighty bits of general purpose data memory

3 **How many ports are available in 8051 micro controller?**

There are mainly four ports available in this 8051 micro controller. They are

Port0: serve as inputs, outputs, or, when used together, as a bi-directional low order address and as data bus for external memory.

Port1: has got no dual functions.

Port2: may be used as an input / output port similar in operation to port 1.The alternate use of port2 is to supply a high-order address byte in conjunction with the Port0 low-order byte to address external memory.

Port3: is an input / output pin similar to the Port 1. In this case each and every pin has an additional function.

4 **How to select the register bank of Intel 8051. (May 2015)**

RS0 and RS1 are the D3 and D4 bits present in the 8-bit register of the PSW

0	C213.4	BANK 0 is selected from Internal ROM
0	C213.4	BANK 1 is selected from Internal ROM
1	C213.4	BANK 2 is selected from Internal ROM
1	C213.4	BANK 3 is selected from Internal ROM

5 **What is meant by microcontroller?**

A device which contains the microprocessor with integrated peripherals like memory, serial ports, parallel ports, timer/counter, interrupt controller, data acquisition interfaces like ADC, DAC on single chip is called microcontroller.

6 **List the flags of 8051 and give their usage.**

Status flags: These flags are modified according to the result of arithmetic andlogical operations. 1. Carry flag, 2. Auxiliary carry flag, 3. Overflow flag, 4. Parity flag and General purpose user flags: These flags can be set or cleared by the programmer as desired 1. Flag 0, 2. GF0, 3. GF1

7 **What are the various baud rates possible in 8051 and how are they set?**

Baud rate	TH1 (Dec)	TH1 (Hex)
9600	-3	FD
4800	-6	FA
2400	-12	F4
1200	-24	E8

8 **What are the various types of sensors that can be interfaced with 8051? (Apr/ May 2017)**

1. Temperature Sensor, 2. IR Sensor, 3. Ultrasonic Sensor, 4. Touch Sensor, 5. ProximitySensors, 6. Pressure Sensor, 7. Level Sensors, 8. Smoke and Gas Sensors.

9 **Define Baud rate of 8051. (Apr/May 2016)**

In serial communication the data is rate known as the baud rate, which simply means the number of bits transmitted per second. In the serial port modes that allow variable baud rates, this baud rate is set by timer 1. The 8051 serial port is full duplex.

10 **What are the applications of stepper motor?**

Industrial Machines – Stepper motors are used in automotive gauges and machine tooling automated production equipment's. **Security** – new surveillance products for the security industry. **Medical** – Stepper motors are used inside medical scanners, samplers, and also found inside digital dental photography, fluid pumps, respirators and blood analysis machinery. **Consumer Electronics** Stepper motors in cameras for digital camera focus and zooming

11 **Write a program to generate a 10 KHz square wave using 8051?**

```
MOV
TMOD,#00000001B
MAIN: SETB P1.0
ACALL DELAY
CLR P1.0
ACALL DELAY
SJMP MAIN
```

```
DELAY: MOV TH0,#0FFH
MOV TL0,#0CEH
SETB TR0
HERE:JNB
TF0,HERECLR TR0
CLR TF0
SETB
P1.0RET
END
```

12 **What is the function of IE register in 8051?**

The Interrupt Enable SFR is used to enable and disable specific interrupts. The low 7 bits of the SFR are used to enable/disable the specific interrupts, where as the highest bit is used to enable or disable ALL interrupts. Thus, if the high bit of IE is 0 all interrupts are disabled regardless of whether an individual interrupt is enabled by setting a lower bit.

13 **Compare polling and interrupt. (Apr/May 2016)**

Interrupt is a signal to the microprocessor from a device that requires attention. The microprocessor will respond by setting aside execution of its current task and deal with the interrupting device. When the interrupting device has been dealt with, the microprocessor continues with its original task as if it had never been interrupted.

In Polling the processor continuously polls or tests every device in turn as to whether it requires attention (e.g. has data to be transferred). The polling is carried out by a polling program that shares processing time with the currently running task.

14 **Write a program to generate a 1ms delay using 8051?**

```
DELAY: MOV TMOD,#00000001B
MOV TH0,#0FCH
MOV TL0,#018H
SETB TR0
HERE: JNB
TF0,HERECLR TR0
CLR TF0
RET
```

15 **What is the significance of TCON register?**

The Timer Control SFR is to configure, modify the way in which the 8051's two timers operate. This SFR controls whether each of the two timers is running or stopped and contains a flag to indicate that each timer has overflowed. Some non-timer related bits are

located in the TCON SFR. These bits are used to configure the way in which the externalinterrupts are activated.

16 **List the 8051 interrupts with its priority (Apr/May 2017)**

Types of Interrupts in 8051 Microcontroller

The 8051 microcontroller can recognize five different events that cause the main program tointerrupt from the normal execution. These five sources of interrupts in 8051 are:

1. Timer 0 overflow interrupt- TF0
2. Timer 1 overflow interrupt- TF1
3. External hardware interrupt- INT0
4. External hardware interrupt- INT1
5. Serial communication interrupt- RI/TI

17 **Write a note on RS-232 communication.**

The EIA RS-232 serial communication standard is a universal standard, originally used to connect teletype terminals to modem devices. Figure shows a PC connected to a device such as a modem or a serial printer using the RS-232 connection. In a modern PC the RS-232 interface is referred to as a COM port. The COM port uses a 9-pin D-type connector to attach to the RS-232 cable. The RS-232 standard defines a 25-pin D-type connector but IBM reduced this connector to a 9-pin device so as to reduce cost and size.

18 **What is asynchronous serial communication?**

Since data is sent is a serial fashion, without any reference to a timing clock to help synchronies the receiver clock in terms of frequency and phase, the system is said to be non-synchronous, or synchronous. The baud rate clocks at each end of the RS-232 link are set to the same frequency values but there is no mechanism to synchronise these clocks.

19 **What are the different modes in which timer 2 can operate? APRIL/MAY 2019.**

Mode 0

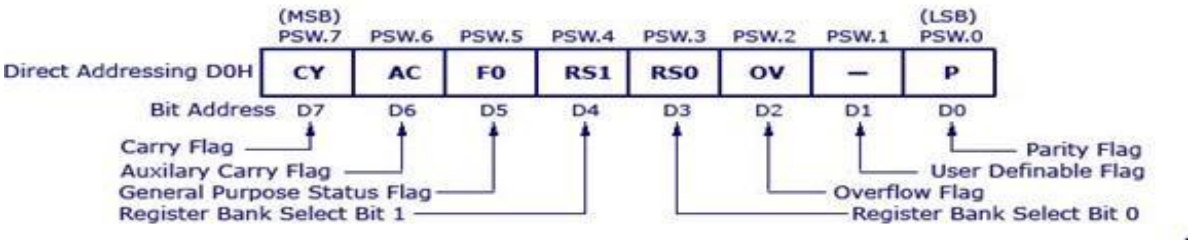
Mode 1

Mode 2

20 **When is an external memory access generated in 8051?APRIL/MAY 2019.**

After request from peripheral to 8051 the external memory access is issued.

21 **Draw the PSW of 8051. (May 2015)**



22 **List any applications of Microcontroller.**

1. Building control(Fire detection)
2. Industrial control (Process control)

3. Motor speed control(Stepper motor control)
4. Stand alone devices(Color Xerox machine)

Automobile applications (Power steering)

23 **What is the function of DPTR register?**

The data pointer (DPTR) is the 16-bit address register that can be used to fetch any 8 bit datafrom the data memory space. When it is not being used for this purpose, it can be used as two eight bit registers, DPH and DPL

24 **What is the significance of EA line of 8051 microcontroller? (May/Jun 2014)**

When there is no on-chip ROM in microcontroller and EA pin is connected to GND, itindicates that the code is stored in external ROM.

25 **What is the difference between MOVX and MOV ? (Nov/Dec 2013)**

The MOV instruction is used to access code space of on-chip ROM and MOVX instruction is used to access data space or external memory.

26 **How is memory organized in 8051?**

8051 can access up to 64kb of program memory and 64kb of external data memory and internal data RAM locations.

27 **What are the different ways of operand addressing in 8051? (Apr/May 2016)**

Different ways of addressing modes are**1)** Immediate addressing mode **2)** Direct addressing mode **3)** Register direct addressing mode **4)** Register indirect addressing mode **5)** Indexed addressing mode.

28 **Write an 8051 ALP to toggle P1 a total of 200 times. Use RAM location 32H to hold your counter value instead of registers R0-R7. (Apr/May 2016)**

```
        MOV P1,#55H ;P1=55H
        MOV 32H,#200 ;load counter value into RAM loc 32H
LOP1:   CPL P1 ;toggle P1
        ACALL DELAY
        DJNZ 32H,LOP1 ;repeat 200 times
```

29 **Mention some of the 8051 special function register.**

ACC: Accumulator, B: B-Register, PSW: Program Status Word, SP: Stack Pointer, DPTR: Data Pointer, IE: Interrupt Enable, SCON: Serial Control, PCON: Power Control.

30 **What is the function of XTAL 1 and XTAL 2 pins?**

8051 internal clock circuit. In this crystal of proper frequency can be connected to these twopins. XTAL 1 is connected to GND and oscillator signal is connected to XTAL 2.

31 **Write an ALP to add the values ABH and 47H. Store the result in R1.**

```
        MOV A, #AB H
```

ADD A, #47 H

MOV R1,

A L1: SJMP

L1

32 **What are the uses of accumulator register?**

The accumulator registers (A and B at addresses 00E0h and 00F0h, respectively) are used to store temporary values and the results of arithmetic operations.

33 **What is PSW?**

Program status word (PSW) is the set of flags that contains the status information and is considered as one of the special function register.

34 **What is data pointer (DTPR)?**

It is a 16-bit register that contains a higher byte (DPH) and lower byte (DPL) of a 16-bit external data RAM address. It is accessed as a 16-bit register or two 8-bit registers. It has been allotted two addresses in the special function register bank, for its two bytes DPH and DPL.

35 **Why oscillator circuit is used?**

Oscillator circuit is used to generate the basic timing clock signal for the operation of the circuit using crystal oscillator.

36 **What is the purpose of using instruction register?**

Instruction register is used for the purpose of decoding the opcode of an instruction to be executed and gives information to the timing and control unit generating necessary signals for the execution of the instruction.

37 **Give the purpose of ale/prog signal.**

ALE/PROG is an address latch enable output pulse and indicates that valid address bits available on the respective pins. The ALE pulses are emitted at a rate of one-sixth of the oscillator frequency. The signal is valid only for external memory accesses. It may be used for external timing or clockwise purpose. One ALE pulse is skipped during each access to external data memory.

38 **Differentiate between program memory and data memory.**

i. In stores the programs to be executed. ii. It stores only program code which is to be executed and thus it need not be written, so it is implemented using EPROM It stores the data, line intermediate results, variables and constants required for the execution of the program. The data memory may be read from or written to and thus it is implemented using RAM.

39 **What are addressing modes?**

The various ways of accessing data are called addressing modes.

40 **Give the addressing modes of 8051?**

There are six addressing modes in 8051.They are Direct addressing Indirect addressing Register instruction Register specific (register implicit) Immediate mode Indexed addressing

41 **What is direct addressing mode?**

The operands are specified using the 8-bit address field, in the instruction format. Only internal data RAM and SFRS can be directly addressed. This is known as direct addressing mode. Eg: Mov R0, 89H

42 **What is indirect addressing mode?**

In this mode, the 8-bit address of an operand is stored in a register and the register, instead of the 8-bit address, is specified in the instruction. The registers R0 and R1 of the selected bank of registers or stack pointer can be used as address registers for storing the 8-bit addresses. The address register for

16-bit addresses can only be „data pointer"(DPTR). Eg: ADD A, @ R0.

43 **What is meant by register instructions addressing mode?**

The operations are stored in the registers R0 – R7 of the selected register bank. One of these eight registers (R0 – R7) is specified in the instruction using the 3-bit register specification field of the opcode format. A register bank can be selected using the two bank select bits of the PSN. This is called as register instruction addressing mode Eg: ADD A, R7.

44 **What is immediate addressing mode?**

An immediate data ie., a constant is specified in the instruction, after the opcode byte. Eg: MOV A, #100 The immediate data 100 (decimal) is added to the contents of the accumulator. For specifying a hex number, it should be followed by H. These are known as immediate addressing mode.

45 **List the five addressing modes of 8051 microcontroller.**

The five addressing modes are, I. Immediate addressing II. Register addressing III. Direct addressing IV. Register indirect addressing V. Indexed addressing.

46 **WHAT ARE THE TWO MAIN FEATURES OF SFR ADDRESSES?**

The following two points should be noted SFR addresses. The special function registers have addresses between 80H and FFH. These addresses are above 80H, since the addresses 00 to 7FH are addresses of RAM memory inside the 8051. II. Not all the address space of 80 to FH is used by the SFR. The unused locations 80Hto FFH are reserved and must not used by the 8051 programmer.

47 **What is the difference between direct and register indirect addressing mode?**

Loop is most efficient and is possible only in register indirect addressing whereas looping is not direct addressing mode.

48 **What are single bit instructions?**

Give example. Instructions that are used for single bit operation are called single bit instructions. Examples: SETB bit CLR bit CPL bit

49 **Write a program to save the status of bits p1.2 and p1.3 on ram bit LOCATIONS 6 AND 7 RESPECTIVELY.**

MOV C, P1.2; save status of P1.2 on CY MOV O6, C; save carry in RAM bit location 06 MOV C, p1.3; save status of p1.3 on CY MOV 07, C; save carry in RAM bit location 07.

50 **Write a program to see if bits 0 and 5 of register b r1. If they are not, make them so and save it in r0.**

JNB OFOH, NEXT – 1; JUMP if B.0 is low SET BOFOH; Make bit B.0 high NEXT – 1:JNB OF5H, NEXT – 2; JUMP if B.5 is low SETB OF5H; Make B.5 high NEXT – 2: MOV R0, B; Save register B.

PART-B

1 **Draw the block diagram of Intel 8051 timer/counter and explain its different modes of operations. (May 2015)**

Ans: Refer: Mohamed Ali Mazidi, Janice Gillispie Mazidi,Rolin McKinlay, "The 8051 Microcontroller and Embedded Systems: Using Assembly and C", Second Edition, Pearson Education, 2011.**PG.NO:202-221**

2 **Explain how to interface ADC in detail.(16) (Dec 2013)**

Ans: Refer: Mohamed Ali Mazidi, Janice Gillispie Mazidi,

Rolin McKinlay, "The 8051 Microcontroller and Embedded Systems: Using Assembly

and C", Second Edition, Pearson Education, 2011.**PG.NO:322-327**

4 **Explain how to interface DAC in detail.(13)APRIL/MAY 2019**
Ans: Refer: Mohamed Ali Mazidi, Janice Gillispie Mazidi,

Rolin McKinlay, "The 8051 Microcontroller and Embedded Systems: Using Assembly and C", Second Edition, Pearson Education, 2011.**PG.NO:344-348**

6 **With necessary hardware & software details explain how to interface LCD'S with 8051(16) (May 2015)**
Ans: Refer: Mohamed Ali Mazidi, Janice Gillispie Mazidi,

Rolin McKinlay, "The 8051 Microcontroller and Embedded Systems: Using Assembly and C", Second Edition, Pearson Education, 2011.**PG.NO:300-306**

7 **Explain the different modes of operation of serial port in 8051, indicating various registers associated with it. (16) (Apr/May 2016)**

Ans: Refer: Mohamed Ali Mazidi, Janice Gillispie Mazidi,

Rolin McKinlay, "The 8051 Microcontroller and Embedded Systems: Using Assembly and C", Second Edition, Pearson Education, 2011.**PG.NO:244-231**

8 **How do you interface 8051 microcontroller with keyboard? Explain in detail.**
Ans: Refer: Mohamed Ali Mazidi, Janice Gillispie Mazidi,Rolin McKinlay, "The 8051 Microcontroller and Embedded Systems: Using Assembly and C", Second Edition, Pearson Education, 2011.**PG.NO:311-314**

9 **(i) Vin=2.25V, Vref=5V, NO. of data lines are 5. Convert the given analog quantityto its equivalent digital output quantity. (8) (May 2014)**

(ii) **Explain the different techniques to convert digital quantity to its equivalent analog quantity**.
Ans: Refer: Mohamed Ali Mazidi, Janice Gillispie Mazidi,

Rolin McKinlay, "The 8051 Microcontroller and Embedded Systems: Using Assembly and C", Second Edition, Pearson Education, 2011.**PG.NO:331,344-346**

10 **Explain in detail the procedure to interface stepper motor with 8051. (May 2015) Ans:**
Refer: Mohamed Ali Mazidi, Janice Gillispie Mazidi,Rolin McKinlay, "The 8051 Microcontroller and Embedded Systems: Using Assembly and C", Second Edition, Pearson Education, 2011.**PG.NO:432-438**

11 **Write a program for generation of unipolar square waveform of 1KHZ frequency using Timer 0 of 8051 in mode 0. Consider the system frequency as 12 MHZ.(Apr/May 2017)**
Ans: Refer: Mohamed Ali Mazidi, Janice Gillispie Mazidi,

Rolin McKinlay, "The 8051 Microcontroller and Embedded Systems: Using Assembly and C", Second Edition, Pearson Education, 2011.**PG.NO:203**

12 **Explain the architecture of 8051 with its diagram.**

Ans: Refer: Mohamed Ali Mazidi, Janice Gillispie Mazidi,Rolin McKinlay, "The 8051 Microcontroller and Embedded Systems: Using Assembly and C", Second Edition, Pearson Education, 2011.**PG.NO:185-191**

13 **Explain the I/O pins ports and circuit details of 8051 with its diagram.**

Ans: Refer: Mohamed Ali Mazidi, Janice Gillispie Mazidi,Rolin McKinlay, "The 8051 Microcontroller and Embedded Systems: Using Assembly and C", Second Edition, Pearson Education, 2011.**PG.NO:192-301**

14 **Explain the different addressing modes of 8051**

Ans: Refer: Mohamed Ali Mazidi, Janice Gillispie Mazidi,Rolin McKinlay, "The 8051 Microcontroller and Embedded Systems: Using Assembly and C", Second Edition, Pearson Education, 2011.**PG.NO:202-221**

15 **With example explain the different instruction set of 8051 microcontroller**

Ans: Refer: Mohamed Ali Mazidi, Janice Gillispie Mazidi,Rolin McKinlay, "The 8051 Microcontroller and Embedded Systems: Using Assembly and C", Second Edition, Pearson Education, 2011.**PG.NO:222-241**

UNIT II - EMBEDDED SYSTEMS

TWO MARKS

1. Define a System.

A System is defined as a way of doing one or more tasks according to a program.

2. What is an embedded system?

An embedded system employs a combination of hardware & software (a "computational engine") to perform a specific function; is part of a larger system that may not be a "computer"; works in a reactive and time-constrained environment.

3. In what ways CISC and RISC processors differ?

CISC	RISC
It provides number of addressing Modes	It provides very few addressing modes
It has a micro programmed unit with a control memory	It has a hardwired unit without a control memory
An easy compiler design	Complex compiler design
Provide precise and intensive calculations slower than a RISC	Provide precise and intensive calculations faster than a CISC

4. Define system on chip (SOC) with an example

Embedded systems are being designed on a single silicon chip called system on chip. SOC is a new design innovation for embedded system. ***Ex. Mobile phone.***

5. What are the applications of an embedded system?

Embedded Systems: Applications:

- Consumer electronics, e.g., cameras, camcorders, etc.,
- Consumer products, e.g., washers, microwave ovens, etc.,
- Automobiles,e.g.,anti-lock braking, engine control, etc.,
- Industrial process controllers & avionics/defense applications
- Computer/Communication products, e.g., printers, FAX machines, etc.,
- Emerging multimedia applications & consumer electronics

6. What are the complicating factors in embedded design?

Complicating factors in the design of embedded systems

- Many of the subtasks in design are intertwined.
- Allocation depends on the partitioning, and scheduling presumes a certain allocation.
- Predicting the time for implementing the modules in hardware or software is not very easy, particularly for tasks that have not been performed before.

7. What are the real-time requirements of an embedded system?

Hard-real time systems: where there is a high penalty for missing a deadline e.g., control systems for aircraft/space probes/nuclear reactors; refresh rates for video, or DRAM. Soft real-time systems: where there is a steadily increasing penalty if a deadline is missed.

e.g., laser printer: rated by pages-per-minute, but can take differing times to print a page (depending on the \"complexity\" of the page) without harming the machine or the customer.

8. What are the functional requirements of embedded system?

- Data Collection
- Sensor requirements
- Signal conditioning
- Alarm monitoring
- Direct Digital Control
- Actuators
- Man-Machine Interaction

1. informs the operator of the current state of the controlled object
2. Assists the operator in controlling the system.

9. What are the main components of an embedded system?

Three main components of embedded systems:

The Hardware
Application Software
RTOS

10. Explain digital signal processing in embedded system continued digitization of signals increasing the role of DSP in ES.

- Signals are represented digitally as sequence of "samples"
- ADC's are moving closer to signals

11. What are the two essential units of a processor on an embedded system and what does the execution unit of a processor in an embedded system do?

Program flow control unit (CU) and Execution unit (EU)

The execution unit implements data transfer and data conversion. It includes ALU and circuits that execute instruction for jump, interrupt, etc.,

12. Define microprocessor.

A microprocessor fetches and processes the set of general-purpose instructions such as data transfer, ALU operations, stack operations, I/O operations and other program control operations.

13. When is Application Specific System processors (ASSPs) used in an embedded system?

An ASSP is dedicated to real-time video processing applications such as video conferencing, video compression and decompression systems. It is used as an additional processing unit for running application specific tasks in the place of processing using embedded software.

14. Define ROM image.

ROM image in a system memory consists of:

Boot-up program, stack address pointer, program counter address pointer, application tasks, ISRs, input data, RTOS and vector addresses. Bytes at each address must be defined to create ROM image.

15. Define device driver.

A device driver is software for controlling, reading, sending a byte of stream of bytes from/to the device.

16. Give the reactivity in embedded system.

Closed systems

- Execution indeterminacy confined to one source
- Causal relations are easily established.

Open systems

- Indeterminacy from multiple sources, not controllable or observable by the programmer not possible to infer causal relations.

17. Differentiate top-down and bottom-up design. (APRIL/MAY 2014)

Top-Down design	**Bottom-Up design**
We begin with the most abstract description of the system and conclude with concrete details.	We start with components to build a system.
We have perfect insight into how the later stages of the design process will turn out.	We do not have perfect insight into how the later stages of the design process will turn out.
More experience on system refinement.	Less experience on system refinement.

18. Write short notes on ARM processor. (Nov/Dec 2013)

ARM is actually a family of RISC architectures that have been developed over many years.ARM instructions are written one per line, starting after the first column. Comments begin with a semicolon and continue to the end of the line. A label, which gives a name to a memory location, comes at the beginning of the line, starting in the first column.

Example

```
LDR r0,[r8] ; a comment
Label Add r4, r0, r1
```

The ARM processor can be configured at power-up to address the bytes in a word in either little-endian mode (or) big-endian mode.

19. List the functions of ARM Processor in Supervisor mode.

- The argument of the SWI instruction is a 24-bit immediate value that is passed on to the supervisor mode that allows the program to request various services
- The old value of the CPSR just before the SWI is stored in a register called the Saved programmed status register

20. Differentiate Between CISC and RISC processor ?

Complexities instruction taking multiple cycles	**Simple instruction taking one cycle**
Any instruction may refer to memory	Only LOAD/STORE refer to memory
We have perfect insight into how the later stages of the design process will turn out.	We do not have perfect insight into how the later stages of the design process will turn out.
More experience on system refinement.	Less experience on system refinement.

21. What are the Instruction set features useful for embedded programming?

Complex instruction set computers (CISC), these machine provided a variety of instructions that may perform very complex tasks, such as string searching. RISC-reduced instructions set computers these machine provide somewhat fewer and simpler instructions.

22. **Mention the features of LPC214x**?

Features of LPC214x series controllers: 1. 8 to 40 kB of on-chip static RAM and 32 to 512 kB of on-chip flash program memory. 128 bit wide interface/accelerator enables high speed 60 MHz operation

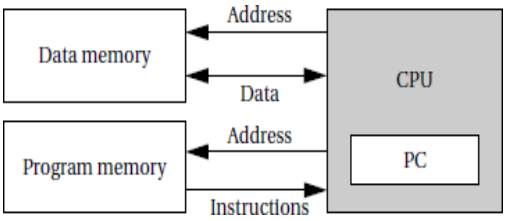
23. List the memory functions of ARM Processor in supervisor mode.?

The ARM instruction that puts the CPU in supervisor mode is called SWI. SWI causes the CPU to go into supervisor mode and sets the PC TO 0*08. In supervisor mode CPSR are all set to 1 indicate that the CPU is in supervisor mode. The old value of the CPSR just before the SWI is stored in a register called the Saved programmed status register (SPSR).

24. What are the Instruction set features?

It uses a variable-length instruction coding, and a number of instructions take a memory address as one of the operands. The ARM instruction set also has some decidedly non-RISC features.

25. Draw Harvard Architecture Diagram?



26. Suggest the rules which apply to ARM data processing instruction ?

- Data processing instructions can processes one of their operands using the barrel shifter
- Data processing instructions are processed within the arithmetic logic unit (ALU)

27. What is meant by conditional execution?

- Conditional execution is an event used to controls whether or not the core will execute an instruction. Most instructions have a condition attribute that determines if the core will execute .it based on the setting of the condition flags.

28. What is the purpose of supervisor mode ?

- Supervisor mode is a mode that provide hardware checks to ensure that the program do not interface with each other .It is provided by the CPU

29. State the function of co processor ?

Co –processor is a computer processor used to supplement the function of the primary processor .Operations performed by the co processor may be floating point Arithmetic, Graphics ,Signal processing ,string processing.

30. Define Stack ?

The stack is actually just an area of memory whose highest address is in register R13.For this reason ,Register R13 is referred to as the stack pointer (SP).Usually,the stack is used for storing data when subroutines are called .

31. Define Timer ?

- Timer is specific type of clock which is used to measure the time intervals.It provides /Measures the time interval by counting the input clocks timer needs a clock to work .We can provide /Measure any time interval if we know the time of one clock period .

32. Define counter?

- Counter is the unit which is similar to timers but works in a reverese manner to the timers.it counts the external events or we can say external clock ticks. It is mostly used to measure frequency from the counts of clock ticks.

33. List out the various compilation techniques. (NOV/DEC 2013)

(i) Machine independent optimization

(ii) Instruction-level optimizations and code generation.

34. What are different CPU buses? State the function of each one. (MAY/JUNE 2013)

(i) DMA Bus-it is a bus operation that allows reads and writes not controlled by the CPU.DMA transfer is controlled by a DMA controller, which requests control of the bus from the CPU. After gaining control, the DMA controller performs read and write operations directly between devices and memory.

(ii) High-speed buses may provide wider data connections.

(i) A high speed bus usually requires more expensive circuits and connectors. The cost of low speed devices can be held down by using a lower speed, lower-cost bus.

(ii) AMBA BUS(ARM BUS) supports CPUs, memories and peripherals integrated in a system-on-silicon.it includes two buses AHB(AMBA high performance) and APB(AMBA peripherals)

35. State the principle of basic compilation technique. (MAY/JUNE 2013)

The high level language program is parsed to break it into statements and expressions. In addition symbol table is generated, which includes all the named objects in the program,

36. What is the bus protocol especially, the four cycle handshake? (April/May 2014)

The basic building block of most bus protocols is the four cycle handshake. The handshake ensures that when two devices want to communicate, one is ready to transmit and other is ready to receive.

The handshake uses a pair of wires dedicated to the handshake: **enq** (enquiry) and **ack**(acknowledge)

37. What is a data flow graph? (April/May 2014)

A data flow graph is a model of a program with no conditionals. In a high level programming language, a code segment with no conditionals with only one entry and exit point is known as basic block.

38. What is memory map input-output interface? (April/May 2015)

Some I/O devices are designed to interface directly to a particular bus, forming glue less interfaces. But glue logic is required when a device is connected to a bus for which it is not designed.

39. State the function of version in ARM?

Versions

V4	ARM instructions only
V4T	Thumb instructions also added
V5	More advanced ARM &Thumb instruction

40. Define Data Processing?

Instruction which program arithmetic/logical computations

41. Define Arithmetic Instruction?

- Addition & subtraction-3 operand instruction the destination is always register. The source operands may be register or one of them may be an immediate data.

42. What are the Testing Strategies used in the Program Validation (APRIL 2016)

- ❖ Black-box methods generate tests without looking at the internal structure of the program.
- ❖ Clear-box(also known as white-box) methods generate tests based on the program structure.

43. Define Debugging and Complier

- Debugging is a process of removing errors during run time and execution time of program.
- Complier is a translator which converts high level language into assembly level language which later converted into binary codes.

44. What is Component Interfacing?

- Some I/O devices are designed to interface directly to a particular bus, forming glue-less interfaces. But glue logic is required when a device is connected to a bus for which it is not designed.
- It is a process of interfacing glue logic between a system bus and the device for the device which is not made for a particular type of system bus.

45. What are the uses of test Bench Code Program in debugging?

The test bench generates inputs to simulate the actions of the input devices; it may also take the output values and compare them against expected values, providing valuable early debugging help.

46. Name any two techniques used to optimize execution time of a program. (NOV/DEC 2012)

(i) Compiler
(ii) Scheduling

47. What does a linker do? (NOV/DEC 2012)

A linker allows a program to be stitched together out of several smaller pieces. The linker operates on the object files created by the assembler and modifies the assembled code to make the necessary links between files.

48. What are CPU Buses? (NOV/DEC 2013)

The bus is the mechanism by which the CPU communicates with memory and devices. One of the major roles of the bus is to provide an interface to memory. A bus is at a minimum, a collection wires, but the bus also defines a protocol by which the CPU, memory, and devices communicate.

49. What are the entries of a requirement form?

- Name
- Purpose
- Inputs and outputs
- Functions
- Performance
- Manufacturing cost
- Power
- Physical size and weight

50. Give some examples of functional requirements?

1. Performance
2. Cost
3. Physical size and weight
4. Power

PART-B

1. **Define embedded system design Process? Explain**.
   Refer page no.10-28, Marilyn Wolf, "Computer as Components Principles of Embedded Computing System Design", Third Edition, Morgan Kaufman is an imprint of Elsevier, 2012

2. **Design example: Model train controller & Explain?**
   Refer page no.28-42, Marilyn Wolf, "Computer as Components Principles of Embedded Computing System Design", Third Edition, Morgan Kaufman is an imprint of Elsevier, 2012

3. **Explain about Embedded system with suitable example**
   Refer page no.1-6, Marilyn Wolf, "Computer as Components Principles of Embedded Computing System Design", Third Edition, Morgan Kaufman is an imprint of Elsevier, 2012

4. **Explain the Requirement Analysis – Specifications?**
   Refer page no.389-394, Marilyn Wolf, "Computer as Components Principles of Embedded Computing System Design", third Edition, Morgan Kaufman is an imprint of Elsevier, 2012

5. **Explain the Specifications-System analysis and architecture design?**
   Refer page no.398-402, Marilyn Wolf, "Computer as Components Principles of Embedded Computing System Design", third Edition, Morgan Kaufman is an imprint of Elsevier, 2012

6. **Demonstrate the advanced features of the ARM Core.**
   Refer Notes

7. **From the fundamentals, draw the architecture of ARM processor with relevant Explanation.**
   Refer Notes

8. **(i)Point out the operating modes of ARM. (ii)Briefly explain the Register set of ARM.**
   Refer Notes

9. **The content of registers is given as below R1 = 0xEF00DE12, R12 = 0x0456123F, R5 = 4, R6 = 28.Find the result in the destination register when the following instructions are executed**

   a. **LSL R1, #8**
   b. **ASR R1,R5**
   c. **ROR R2,R6**

10. **Explain the platform-level performance analysis?**
    Refer page no.188-192, Marilyn Wolf, "Computer as Components Principles of Embedded Computing System Design", Third Edition, Morgan Kaufman is an imprint of Elsevier, 2012

11. **Explain the Components for embedded programs- Models of programs?**
    Refer page no.200-203, Marilyn Wolf, "Computer as Components Principles of Embedded Computing System Design", Third Edition, Morgan Kaufman is an imprint of Elsevier, 2012

12. **Explain the Assembly, linking and loading – compilation techniques?**
    Refer page no.228-240, Marilyn Wolf, "Computer as Components Principles of Embedded Computing System Design", Third Edition, Morgan Kaufman is an imprint of Elsevier, 2012

13. **Explain the Program level performance analysis – Software performance optimization?**
    Refer page no.254-264, Marilyn Wolf, "Computer as Components Principles of Embedded Computing System Design", Third Edition, Morgan Kaufman is an imprint of Elsevier, 2012

14. **Explain the various debugging techniques in the development of embedded system.**
    Refer page no.183,Chapter4.6.2 , 4.6.3, Marilyn Wolf, "Computer as Components Principles of Embedded Computing System Design", Third Edition, Morgan Kaufman is an imprint of Elsevier, 2011

15. **Explain in detail about the complication process in high level languages.(8)**
    Refer page no.220,Chapter5.3,5.4, Marilyn Wolf, "Computer as Components Principles of Embedded Computing System Design", Third Edition, Morgan Kaufman is an imprint of Elsevier, 2011

UNIT-III

PROCESS AND OPERATING SYSTEMS

TWO MARKS

1. Mention the elements of C program.

- Files:
  - Header files
  - Source files
  - Configuration files
  - Preprocessor directives
- Functions:
  - Macro function
  - Main function
  - Interrupt service routines or device drivers
- Others:
  - Data types
  - Data structures
  - Modifiers
  - Statements
    Loops and pointers

2. What is Context Switching? (NOV/DEC 2012) (NOV/DEC 2013) (APRIL/MAY 2014)(APRIL/MAY 2015)

- ❖ It is the computing process of storing and restoring state (context) of CPU so that execution can be resumed from the same point at a later time.
- ❖ It is an essential feature of Multi-tasking Operating System.

3. Write any two Advantages of Multi-processor OS

- ❖ Since Multi-processor OS is a logical extension of Multi-programming OS many processors are present in the system in which each different processor carry out different function.
- ❖ It has the additional property that every memory can be read as fast as every other memory word called uniform memory access multiprocessors.

4. Define process. (NOV/DEC 2013)

A process is a program that performs a specific function.

5. Define (TCB)

The TCB stands for Task Control Block which holds the control of all the tasks within the block. It has separate stack and program counter for each task.

6. What is a thread?

A thread otherwise called a lightweight process (LWP) is a basic unit of CPU utilization, it comprises of a thread id, a program counter, a register set and a stack. It shares with other threads belonging to the same process its code section, data section, and operating system resources such as open files and signals.

7. What are the benefits of multithreaded programming?

The benefits of multithreaded programming can be broken down into four major categories:

- Responsiveness
- Resource sharing
- Economy
- Utilization of multiprocessor architectures

8. Define RTOS.

A real-time operating system (RTOS) is an operating system that has been developed for real-time applications. It is typically used for embedded applications, such as mobile telephones, industrial robots, or scientific research equipment.

9. Define CPU scheduling.

CPU scheduling is the process of switching the CPU among various processes. CPU scheduling is the basis of multi-programmed operating systems. By switching the CPU among processes, the operating system can make the computer more productive.

10. Define Synchronization.

Message passing can be either blocking or non-blocking. Blocking is considered to be synchronous and non-blocking is considered to be asynchronous.

11. Define Inter process communication.

Inter-process communication (IPC) is a set of techniques for the exchange of data among multiple threads in one or more processes. Processes may be running on one or more computers connected by a network. IPC techniques are divided into methods for message passing, synchronization, shared memory, and remote procedure calls (RPC). The method of IPC used may vary based on the bandwidth and latency of communication between the threads, and the type of data being communicated.

12. What is a semaphore?

Semaphores -- software, blocking, OS assistance solution to the mutual exclusion problem basically a non-negative integer variable that saves the number of wakeup signals sent so they are not lost if the process is not sleeping another interpretation we will see is that the semaphore value represents the number of resources available

13. Give the semaphore related functions.

A semaphore enforces mutual exclusion and controls access to the process critical sections. Only one process at a time can call the function.
SR Program: A Semaphore Prevents the Race Condition.
SR Program: A Semaphore Prevents Another Race Condition.

14. When the error will occur when we use the semaphore?

- When the process interchanges the order in which the wait and signal operations on the semaphore mutex.
- When a process replaces a signal (mutex) with wait (mutex).
- When a process omits the wait (mutex), or the signal (mutex), or both.

15. What is priority inheritance?

Priority inheritance is a method for eliminating priority inversion problems. Using this programming method, a process scheduling algorithm will increase the priority of a process to the maximum priority of any process waiting for any resource on which the process has a resource lock.

16. Define Mailbox and Pipe.

Mailboxes are software-engineering components used for interprocess communication, or for inter-thread communication within the same process. A mailbox is a combination of a semaphore and a message queue (or pipe).

17. Define Socket.

A socket is an endpoint for communications between tasks; data is sent from one socket to another.

18. Define Remote Procedure Call.

Remote Procedure Calls (RPC) is a facility that allows a process on one machine to call a procedure that is executed by another process on either the same machine or a remote machine. Internally, RPC uses sockets as the underlying communication mechanism.

19. Define thread cancellation & target thread.

The thread cancellation is the task of terminating a thread before it has completed. A thread that is to be cancelled is often referred to as the target thread. For example, if multiple threads are concurrently searching through a database and one thread returns the result, the remaining threads might be cancelled.

20. What is preemptive and non-preemptive scheduling?

• Under non-preemptive scheduling once the CPU has been allocated to a process, the process keeps the CPU until it releases the CPU either by terminating or switching to the waiting state.

• Preemptive scheduling can preempt a process which is utilizing the CPU in between its execution and give the CPU to another process.

21. What is a Dispatcher?

The dispatcher is the module that gives control of the CPU to the process selected by the short-term scheduler. This function involves:

- Switching context
- Switching to user mode
- Jumping to the proper location in the user program to restart that program.

22. What are the various scheduling criteria for CPU scheduling?

The various scheduling criteria are

- CPU utilization
- Throughput
- Turnaround time
- waitingtime
- Response time

23. Define throughput?

Throughput in CPU scheduling is the number of processes that are completed per unit time. For long processes, this rate may be one process per hour; for short transactions, throughput might be 10 processes per second.

24. What is turnaround time?

Turnaround time is the interval from the time of submission to the time of completion of a process. It is the sum of the periods spent waiting to get into memory, waiting in the ready queue, executing on the CPU, and doing I/O.

25. Define race condition.

When several process access and manipulate same data concurrently, then the outcome of the execution depends on particular order in which the access takes place is called race condition. To avoid race condition, only one process at a time can manipulate the shared variable.

26. What is critical section problem?

Consider a system consists of 'n' processes. Each process has segment of code called a critical section, in which the process may be changing common variables, updating a table, writing a file. When one process is executing in its critical section, no other process can allowed executing in its critical section.

27. What are the requirements that a solution to the critical section problem must satisfy?

The three requirements are

- Mutual exclusion
- Progress
- Bounded waiting

28. Define deadlock.

A process requests resources; if the resources are not available at that time, the process enters a wait state. Waiting processes may never again change state, because the resources they have requested are held by other waiting processes. This situation is called a deadlock.

29. What are conditions under which a deadlock situation may arise?

A deadlock situation can arise if the following four conditions hold simultaneously in a system:

- Mutual exclusion
- Hold and wait
- No pre-emption
- Circular wait

30. What does a scheduler do in an operating system environment? (NOV/DEC 2012)

CPU scheduling is the process of switching the CPU among various processes. CPU scheduling is the basis of multi-programmed operating systems. By switching the CPU among processes, the operating system can make the computer more productive.

31. List the various scheduling policies. (MAY/JUNE2013)

- CPU utilization
- Throughput
- Turnaround time
- waitingtime
- Response time

32. What are the power optimization strategies used for processes? (MAY/JUNE2013)(APRIL 2016)

The RTOS and system architecture can use static and dynamic power management mechanisms to help manage the systems power consumption. A power management policy is a strategy for determining when to perform certain power management operations.

33. What are major inter process communication mechanisms? (APRIL/MAY 2014)

a. Shared memory communication
b. Message passing
c. Signals

34. What is cycle static scheduling?

In this type of scheduling, interval is the length of hyper period 'H'. For this interval, a cyclostatic schedule is separated into equal sized time slots.

35. What are the task service functions supported by MUCOS?

- Void OSInit (void)
- Void OSStart(void)
- voidOSTickInit(void)
- void OSIntEnter(void)
- void OSIntExit(void)

36. What are the semaphores related functions supported by MUCOS?

- OS_EventOSSemCreate(unsigned short semval)
- Void OSSemPend(OS_Event *eventPointer,unsigned short timeout,unsigned byte *SemErrPointer)
- unsigned short OSSemAccept(OS_Event*eventPointer)
- unsigned short OSSemPost(OS_Event*eventPointer)

37. What are the three conditions that must be satisfied by the re-entrant function? (May/June 2012)

- A function is called re-entrant function when the following three conditions are satisfied
- All the arguments pass the values and some of the argument is a pointer whenever a calling function calls it.
- When an operation is not atomic, the function should not operate on any variable,
- which is declared but passed by reference not passed by arguments in to the Function.
- That function does not call any other function that is not itself re-entrant.

38. What is critical instant?

It is the situation in which the process or task possess highest response time.

39. What is critical instant analysis?

It is used to know about the schedule of a system. Its says that based on the periods given, the priorities to the processes has to be assigned.

40. Define earliest deadline first scheduling?

This type of scheduling is another task priority policy that uses the nearest deadline as the criterion for assigning the task priority.

41. What is IDC mechanism?

It is necessary for a 'process to get communicate with other process' in order to attain a specific application in an operating system.

42. What are the two types of communication?

1. Blocking communication 2. Non blocking communication

43. Give the different styles of inter process communication?

1. Shared memory.
2. Message passing.

44. What are the states of a process?

a. Running
b. Ready
c. Waiting

45. What is the function in steady state?

Processes which are ready to run but are not currently using the processor are in the 'ready'

state.

***46.* Define scheduling.**

This is defined as a process of selection which says that a use the processor at given time.

47. What is scheduling policy?

It says the way in which processes are chosen to get promotion from ready state to running state.

48. Define hyper period?

It refers the duration of time considered and also it is the least common multiple of all the processes.

49. What is schedulability?

It indicates any execution schedule is there for a collection of process in the system's functionality.

50. What are the types of scheduling?

1. Time division multiple access scheduling.
2. Round robin scheduling.

PART-B

1. Explain the Multiple tasks and multiple processes – Multi rate systems?

Refer page no.308-316, Marilyn Wolf, “Computer as Components Principles of Embedded Computing System Design”, Third Edition, Morgan Kaufman is an imprint of Elsevier, 2012

2. **Explain the Preemptive real-time operating systems- Priority based scheduling?**

   Refer page no.319-330, Marilyn Wolf, "Computer as Components Principles of Embedded Computing System Design", Third Edition, Morgan Kaufman is an imprint of Elsevier, 2012

3. **Explain the Inter process communication mechanisms?**

   Refer page no.340-344, Marilyn Wolf, "Computer as Components Principles of Embedded Computing System Design", Third Edition, Morgan Kaufman is an imprint of Elsevier, 2012

4. **Explain the Evaluating operating system performance?**

   Refer page no.344-348, Marilyn Wolf, "Computer as Components Principles of Embedded Computing System Design", Third Edition, Morgan Kaufman is an imprint of Elsevier, 2012

5. **Explain the power optimization strategies for processes?**

   Refer page no.349-351, Marilyn Wolf, "Computer as Components Principles of Embedded Computing System Design", Third Edition, Morgan Kaufman is an imprint of Elsevier, 2012

6. **Explain the Example Real time operating systems-POSIX-Windows CE?**

   Refer page no.352-358, Marilyn Wolf, "Computer as Components Principles of Embedded Computing System Design", Third Edition, Morgan Kaufman is an imprint of Elsevier, 2012

7. **Discuss any two scheduling policies used in multiprocess environment.**

   Refer page no.352-358, Marilyn Wolf, "Computer as Components Principles of Embedded Computing System Design", Third Edition, Morgan Kaufman is an imprint of Elsevier, 2012

8. **Explain the principle of priority based context switching mechanism. Discuss about the various priority based scheduling algorithms.**

   Refer page no.352-358, Marilyn Wolf, "Computer as Components Principles of Embedded Computing System Design", Third Edition, Morgan Kaufman is an imprint of Elsevier, 2012

9. **Explain the services of operating system in handling multiprocess scheduling and communication**.

   Refer page no.352-358, Marilyn Wolf, "Computer as Components Principles of Embedded Computing System Design", Third Edition, Morgan Kaufman is an imprint of Elsevier, 2012

10. **Discuss in detail about power optimization strategies for CPU operation**

Refer page no.352-358, Marilyn Wolf, "Computer as Components Principles of Embedded Computing System Design", Third Edition, Morgan Kaufman is an imprint of Elsevier, 2012

11. **Explain with a neat diagram inter process communication.**

Refer page no.325,Chapter 6.4, Marilyn Wolf, "Computer as Components Principles of Embedded Computing System Design", Third Edition, Morgan Kaufman is an imprint of Elsevier, 2011

12. **Explain in detail earliest deadline first scheduling.**

Refer page no.320,Chapter 6.3.2, Marilyn Wolf, "Computer as Components Principles of Embedded Computing System Design", Third Edition, Morgan Kaufman is an imprint of Elsevier, 2011

13. **Explain the example real time operating system called POSIX in detail.(8)**

Refer page no.333,Chapter6.6, Marilyn Wolf, "Computer as Components Principles of Embedded Computing System Design", Third Edition, Morgan Kaufman is an imprint of Elsevier, 2011

14. **Explain in detail power optimization strategies in embedded system.(8)**

Refer page no.333,Chapter6.6, Marilyn Wolf, "Computer as Components Principles of Embedded Computing System Design", Third Edition, Morgan Kaufman is an imprint of Elsevier, 2011

15. **Explain in detail power optimization strategies in embedded system**

Refer page no.320,Chapter 6.3.2, Marilyn Wolf, "Computer as Components Principles of Embedded Computing System Design", Third Edition, Morgan Kaufman is an imprint of Elsevier, 2011

UNIT IV

IOT ARCHITECTURE AND PROTOCOLS

TWO MARKS

1. Define IoT.

The Internet of Things (IoT) is a network of physical objects that are fitted with sensors, software and other technologies. Connected to the Internet, these 'things' are able to exchange real time data with other connected devices and systems over networks.

2. List out the Features of IoT.

- Scalability
- Connectivity
- Architecture
- Intelligence
- Security
- Dynamic Or Self-Adapting Nature
- Management, Integration
- Analyzing
- Compact Nature Of Devices

3. State the characteristics of IoT.

- Connectivity
- Intelligence and Identity
- Scalability
- Dynamic and Self-Adapting
- Architecture
- Safety
- Self-Configuring
- Interoperability

4. List out the interfaces used in IoT?

The internet of things, a sensor interface is a bridge between a device and any attached sensor. The interface takes data collected by the sensor and outputs it to the attached device, for example, a water level sensor passing data to a radio transmitter. Different interface options vary in complexity.

5. Define Wireless Sensor Networks.

Wireless sensor networks (WSNs) are designed to sense, collect, and transmit information from the environment to the base station. Under applications such as the Internet of Things and mobile WSNs, intelligent routing is important for achieving better quality of service (QoS) performance of the network.

6. Describe the characteristics of IoT.

- Connectivity
- Intelligence and Identity
- Scalability
- Dynamic and Self-Adapting
- Architecture

- Safety
- Self-Configuring
- Interoperability

7. Explain the role of things in IoT.

The Role of Data Analytics in IoT IoT data analytics involves four main components − IoT Data collection & storage Sensors built into IoT devices gather data about environmental factors including temperature, pressure, and mobility.

8. Mention the applications of IoT.

- Remote Asset Monitoring and Control. One usage of IoT solutions is remote monitoring and control.
- Smart Cities.
- Smart Waste Management System.
- Smart Grids.
- Smart Homes.
- Vehicle Fleet Management.
- Wearable Technology.
- Agriculture.

9. Explain various link layer protocols of IoT.

IoT protocols can be broadly divided into four main layers namely, the physical and MAC layer, the network layer, the transport layer and the application layer.

10. Illustrate the evolutionary trend towards building a IoT?

The evolution of IoT extended beyond consumer devices to industry-specific applications. Sectors such as healthcare, manufacturing, transportation, and agriculture embraced IoT technologies to optimize operations, increase efficiency, and improve safety.

11. Analyze the physical design of IoT.

Physical design knowledge is crucial for selecting suitable devices and sensors, ensuring seamless integration, and optimizing connectivity options in IoT systems. It enables power efficient strategies, facilitates edge computing, and enhances reliability and resilience through redundancy and failover mechanisms. This knowledge ensures robust, efficient, and reliable IoT ecosystems.

12. List out various IoT Protocol.

- MQTT (Message Queueing Telemetry Transport).
- HTTP (Hyper Text Transfer Protocol).
- WebSocket.
- AMQP (Advanced Message Queuing Protocol).
- CoAP (Constrained Application Protocol).
- LwM2M (Lightweight Machine-to-Machine).
- XMPP (Extensive Messaging and Presence Protocol).
- DDS (Data Distribution Service).

13. Examine whether M2M and IoT are same?

- IoT is a subset of M2M technology. In IoT, the communication between two machines without human instruction, making it a part of the M2M communication system.
- The point-to-point communication of M2M is the main difference between M2M and IoT technology. Meanwhile, an IoT system usually locates its devices within a global cloud network that facilitates larger-scale automation and more advanced applications.
- Another key difference between IoT and M2M is scalability. IoT is designed to be highly scalable because devices may also be included in the network and integrated into existing networks with minimal issues. In contrast, maintaining and setting up M2M networks could also be more labor-intensive, as new point-to-point connections must be built for each system.

14. Differentiate between Logical and physical design.

Logical Database Design	Physical Database Design
That describes the data without regard to how they will be physically implemented in the database.	That represents how the actual database is built.
Defines the data elements and their relationship.	Developing the actual database.
Simpler than the Physical database design.	Complex than the Logical database design.

15. Summarize the IOT communication models.

- Client-Server Model
- Publish-Subscribe Model
- Push-Pull Model
- Exclusive Pair Model

16. Highlight the importance of Domain specific IoTs.

- Home Automation
- Smart Cities
- Environment
- Energy systems
- Retail
- Logistics
- Industry
- Agriculture
- Health

17. How IoT communications APIs are classified?

IoT Communications APIs are a set of protocols and interfaces that allow IoT devices and platforms to communicate with one another. These APIs enable developers to create apps that interface with IoT devices over conventional web protocols including HTTP, MQTT, CoAP, and others.

18. Tabulate the different levels of Machine-to-Machine communication.

- Cellular networks.
- Wireless Internet.
- Hard-wired connections.
- Radio-frequency identification (RFID) technology.
- Near-field communication (NFC) systems.
- Bluetooth transmissions

19. Bring out the IOT enabling technologies.

Therefore communication technologies are among the key IoT-enabling technologies. Communication technologies such as non-cellular (Zigbee, Wi-Fi, LoRaWAN, Radio frequency identification) and cellular networks (2G, 3G, 4G, 5G, LTE, NB-IoT) can be the key for such sensor networks to connect and transmit data

20. Summarize the difference between IOT and M2M.

Basis	IoT	M2M
Type of Connection	Network connection	Point to Point (P2P) connection
Communication Protocol	HTTp, FTP	Traditional
System involved	Internet is mandatory	Internet is not required
API Support	Available	Not Available
Applications	B2B, B2C, Cloud computing	Specialised devices
Examples	Smart Wearables, Big Data	Sensors, Transducers

21. What is role of MQTT protocol in IoT?

MQTT (Message Queuing Telemetry Transport) is a messaging protocol for restricted low-bandwidth networks and extremely high-latency IoT devices. Since Message Queuing Telemetry Transport is specialized for low-bandwidth, high-latency environments, it is an ideal protocol for machine-to-machine (M2M) communication.

22. Why do IoT systems have to be Self-adapting and Self- Configuration?

Dynamic and Self Adapting

Iot based applications and devices are made aware of the environment in such a way that change in parameters of their surroundings changes the context and the loT applications can accommodate such changes based on the user's context. Such intelligent systems can be designed and are called self-adapting Iot applications. Example: A surveillance system has cameras with capability of infrared night mode and normal mode. Based on the surrounding environment, the camera should be able to switch between normal mode and night mode. Doing so a central camera can also send notification to other cameras about doing the same. Changing the resolution based on light availability is one more dynamic behavior of cameras.

Self-Configurable

Most of the small toT devices such as sensors, actuators etc, once deployed have very less direct user interaction. Due to this many of such devices are capable of fetching the latest software updates, setup of basic networking and status checks themselves or with very less user intervention. Such devices work together to generate results. Example : Weather Monitoring System

23. What is HTTP?

Hypertext Transfer Protocol (HTTP) is the foundation of the World Wide Web, and is used to load web pages using hypertext links.

24. What is NETCONF?

The Network Configuration Protocol (NETCONF) is an Internet Engineering Task Force (IETF) network management protocol that provides a secure mechanism for installing, manipulating and deleting the configuration data on a network device, such as a firewall, router or switch.

25. What do you mean by Big Data?

Big data is defined as a complex and voluminous set of information comprising structured, unstructured, and semi-structured datasets, which is challenging to manage using traditional data processing tools. It requires additional infrastructure to govern, analyze, and convert into insights.

26. Name the Steps involved in Big Data Analytics.

- Collect Data. Data collection looks different for every organization.
- Process Data. Once data is collected and stored, it must be organized properly to get accurate results on analytical queries, especially when it's large and unstructured.
- Clean Data.
- Analyze Data.

27. What do you mean by REST based API?

A RESTful API is an architectural style for an application program interface (API) that uses HTTP requests to access and use data. That data can be used to GET, PUT, POST and DELETE data types, which refers to the reading, updating, creating and deleting of operations concerning resources.

28. Define Modbus.

Modbus is a data communication protocol that is based on a request-response model. Previously referred to as a master-slave protocol, the Modbus organization replaced the terms master and slave with server and client in 2020

29. What is meant by YANG?

YANG is a data modeling language. The YANG model defines a hierarchical data structure, which can be used for operations based on network configuration management protocols (such as NETCONF/RESTCONF). The operations include configuration, status data, remote procedure calls (RPCs), and notifications. Compared with the SNMP model

MIB, YANG is more hierarchical, can distinguish between configurations and status, and provides high extensibility.

30. Differentiate between IoT reference model and reference architecture.

The IoT Functional Model aims at describing mainly the Functional Groups (FG) and their interaction with the ARM, while the Functional View of a Reference Architecture describes the functional components of an FG, interfaces, and interactions between the components.

31. What do you mean by XMPP?

Extensible Messaging and Presence Protocol (XMPP) is an open XML technology for real-time communication, which powers a wide range of applications including instant messaging, presence and collaboration.

32. What is domain model?

A domain model is generally implemented as an object model within a layer that uses a lower-level layer for persistence and "publishes" an API to a higher-level layer to gain access to the data and behavior of the model. In the Unified Modeling Language (UML), a class diagram is used to represent the domain model.

33. Define IoT reference architecture.

The reference architecture is designed to manage very large numbers of devices. If these devices are creating constant streams of data, then this creates a significant amount of data. The requirement is for a highly scalable storage system, which can handle diverse data and high volumes.

34. Write the advantages of Modbus.

One of the main advantages of Modbus is its compatibility and interoperability. Modbus is a widely adopted and supported protocol that can be used with many different devices and vendors. Modbus is also an open protocol that does not require any licensing fees or royalties.

35. Name the different Sub-models available in IoT domain model.

- Client-Server Model
- Publish-Subscribe Model
- Push-Pull Model
- Exclusive Pair Model

36. Define SDN.

Software-Defined Networking (SDN) is an approach to networking that uses software-based controllers or application programming interfaces (APIs) to communicate with underlying hardware infrastructure and direct traffic on a network.

This model differs from that of traditional networks, which use dedicated hardware devices (i.e., routers and switches) to control network traffic. SDN can create and control a virtual network – or control a traditional hardware – via software

37. Describe the convergence sub layer.

The Convergence Sublayer (CS) is a layer in the Ethernet protocol stack that provides the services necessary for the exchange of data between devices. The CS is responsible for mapping the frames received from the Media Access Control (MAC) sublayer to the appropriate physical layer for transmission across the network.

38. How the BACNet protocol works?

BACnet is a network protocol used in building automation systems (BAS) to control the data exchange between different devices and components. BACnet stands for Building Automation and Control Network. It is a network standard developed by the American Heating Refrigerating and Air Conditioning Engineers. The American National Standard Institute (ANSI) and International Standard for Organization (ISO) have also adopted BACnet as a standard for networking building automation systems.

39. Discuss the unified data standards.

Unified data management (UDM) is a process where a range of disparate data sources are consolidated to create a single source of data, stored within a data warehouse. This data management strategy incorporates people, processes, and technology to treat both the data-silo model that has evolved over time, and the huge quantities of information processed by organizations, resulting in data fatigue.

40. Demonstrate the issues with IoT standardization.

- Platform selection
- Connectivity gaps
- Business model
- Compatibility issues

41. Give the low-rate wireless personal area networks (LR-WPANs).

Low rate wireless personal area networks (LR-WPANs) target low data rate, low power consumption and low cost wireless networking, and offer device level wireless connectivity. They are ideal for applications such as public security, battle field monitoring, inventory tracking, as well as home and office automation.

42. Why do we need IoT security?

Internet of things (IoT)security is the practice of securing IoT devices and the network these devices use. Its primary goals are to maintain the privacy of users and confidentiality of data, ensure the security of devices and other related infrastructures, and allow the IoT ecosystem to function smoothly.

43. Define IoT standardization.

Smart objects produce large volumes of data. This data needs to be managed, processed, transferred and stored securely. Standardization is key to achieving universally accepted specifications and protocols for true interoperability between devices and applications.

44. Mention data protocols.

- Message Queue Telemetry Transport (MQTT)
- HyperText Transfer Protocol (HTTP)
- Constrained Application Protocol (CoAP)
- Data Distribution Service (DDS)
- WebSocket
- Advanced Message Queue Protocol (AMQP)
- Extensible Messaging and Presence Protocol (XMPP)
- OPC Unified Architecture (OPC UA)

45. Define Multilayer framework.

A multi-layered framework maximizes reuse between automation projects for a given combination of automation tools (Microsoft CodedUI, Selenium, rSpec) and programming languages.

46. What do you mean by functional model of IOT?

The IoT Functional Model identifies groups of functionalities, of which most are grounded in key concepts of the IoT Domain Model. A number of these Functionality Groups (FG) build on each other, following the relations identified in the IoT Domain Model.

47. Define Communication model.

The communication model is a systematic representation of the procedure that aids in understanding the human communication process. Models depict the process symbolically and conceptually. They also help to simplify the complex process of conversing and establish where and with whom communication occurs.

48. Analyze various types of communication technologies.

Phones, including telephone calls and text messaging. Computers, including the internet

49. Formulate the features Security in NFC.

- Proximity. NFC has a very small transmission zone – mere inches. ...
- User Initiation. ...
- Secure element validation

50. Classify the perception layer in IoT.

(i) The perception layer is the physical layer, which has sensors for sensing and gathering information about the environment. It senses some physical parameters or identifies other smart objects in the environment. (ii)The network layer is responsible for connecting to other smart things, network devices, and servers.

PART-B

1. **Describe the IoT enabling Technologies.**
2. **Explain M2M Communication with suitable explanations.**
3. **Describe the simplified IoT Architecture.**
4. **Explain IOT reference model.**
5. **Explain IOT function view.**
6. **Explain IOT reference architecture's deployment and operational view.**
7. **Explain Architecture Reference Model of IOT using figure.**
8. **What is IoT Domain Model?**
9. **Describe about Application Layer Protocols: (a) CoAP (b) MQTT**
10. **Summarize in detail IoT data management.**
11. **Explain Main design principles and needed capabilities of IOT.**

UNIT V

IOT SYSTEM DESIGN

TWO MARKS

1. Explain the role of things in IoT.

The Role of Data Analytics in IoT IoT data analytics involves four main components − IoT Data collection & storage Sensors built into IoT devices gather data about environmental factors including temperature, pressure, and mobility.

2. Mention the applications of IoT.

- Remote Asset Monitoring and Control. One usage of IoT solutions is remote monitoring and control.
- Smart Cities.
- Smart Waste Management System.
- Smart Grids.
- Smart Homes.
- Vehicle Fleet Management.
- Wearable Technology.
- Agriculture.

3. Explain various link layer protocols of IoT.

IoT protocols can be broadly divided into four main layers namely, the physical and MAC layer, the network layer, the transport layer and the application layer.

4. Illustrate the evolutionary trend towards building a IoT?

The evolution of IoT extended beyond consumer devices to industry-specific applications. Sectors such as healthcare, manufacturing, transportation, and agriculture embraced IoT technologies to optimize operations, increase efficiency, and improve safety.

5. Analyze the physical design of IoT.

Physical design knowledge is crucial for selecting suitable devices and sensors, ensuring seamless integration, and optimizing connectivity options in IoT systems. It enables power efficient strategies, facilitates edge computing, and enhances reliability and resilience through redundancy and failover mechanisms. This knowledge ensures robust, efficient, and reliable IoT ecosystems.

6. List out various IoT Protocol.

- MQTT (Message Queueing Telemetry Transport).
- HTTP (Hyper Text Transfer Protocol).
- WebSocket.
- AMQP (Advanced Message Queuing Protocol).
- CoAP (Constrained Application Protocol).
- LwM2M (Lightweight Machine-to-Machine).
- XMPP (Extensive Messaging and Presence Protocol).
- DDS (Data Distribution Service).

7. List out various versions of raspberry pi devices till date

- Raspberry Pi 5.
- Raspberry Pi 4 Model B.
- Raspberry Pi 3 Model B+
- Raspberry Pi 3 Model B.
- Raspberry Pi 2 Model B.
- Raspberry Pi 1 Model B+
- Raspberry Pi 3 Model A+
- Raspberry Pi 1 Model A+

8. What is the use of GPIO pins in a IoT device?

Gpio namespace to allow apps to set, read, and react to state changes in the General Purpose Input/Output (GPIO) pins on a Windows IoT (Internet of Things) device. These pins are often used to access sensors, motors, LEDs, etc

9. What is the use of SPI and I2C interfaces on raspberry pi?

The other two serial interfaces are the Serial Peripheral Interface (SPI) and Inter-Integrated-Circuit bus (I2C). SPI on the Pi allows for up to two attached devices, while I2C potentially allows for many devices, as long as their addresses don't conflict.

10. Illustrate how to interface a switch to raspberry pi.

- Plug a button switch into your breadboard. ...
- Connect one leg (signal-in) to a numbered GPIO pin. ...
- Connect the other leg on that side (signal-out) to a ground (GND or -) pin.
- Select Scratch 3 from your Raspberry Pi menu.
- Click on the Add Extension button in the bottom left-hand corner.

11. Write a short note on Light Dependent Resistor.

LDR (Light Dependent Resistor) as the name states is a special type of resistor that works on the photoconductivity principle means that resistance changes according to the intensity of light. Its resistance decreases with an increase in the intensity of light.

12. Explain Raspberry Pi?

The Raspberry Pi is a small, circuit board-sized computer. It consists of a Broadcom system-on-a-chip, which includes a 700MHz ARM processor and graphics processor, as well as 512MB of RAM. It also has an HDMI port, Ethernet port, USB ports, a 3.5mm audio jack, and a microSD card slot for storage.

13. How to run Raspberry pi in headless mode?

- Step 1: Downloading and Installing Raspberry Pi OS in Headless Mode. Insert a microSD card / reader into your computer. ...
- Step 2: Configure the Advanced Options. ...
- Step 3: Find IP Address. ...
- Step 4: SSH Connection to RPI Using Mobaxterm. ...
- Step 5: Enabling VNC Server. ...
- Step 6: Installing a VNC Viewer

14. Define Arduino.

Arduino is an open-source electronics platform based on easy-to-use hardware and software. Arduino boards are able to read inputs - light on a sensor, a finger on a button, or a Twitter message - and turn it into an output - activating a motor, turning on an LED, publishing something online.

15. Define Micro Python.

MicroPython is a reimplementation of the Python programming language that targets microcontrollers and embedded systems. Microcontrollers are computers shrunk onto a single, very small chip. Embedded systems are computers that function within a larger mechanical or electrical system.

PART-B

1. **Discuss in detail the use of embedded computing in the design of IoT Systems.**
    a. **Analyze in detail an exemplary device: Raspberry Pi.**
    b. **Explain in detail the Raspberry Pi interfaces.**
2. **Illustrate the Arduino board details and explain the steps for installing the board.**
3. **Discuss in detail the building blocks of IoT and its functionalities with suitable illustration.**
4. **Explain the smart home automation system in an IOT?**
5. **Discuss the Infrastructures and Buildings development of an IOT?**
6. **Describe the application of Securities and industrial automation in an IoT.**
7. **Explain the types of home appliances and other IoT electronic equipment's.**
8. **Explain the concept of Industry 4.0**
9. **Explain eHealth IOT applications.**
10. **Discuss IoT for Oil and Gas Industry.**
11. **Explain: The smart factory.**
12. **Describe the packages used in python.**
13. **Explain about the classes in python with some examples.**
14. **Mention the flavors of Linux OS supported by Raspberry pi device.**
15. **Discuss about the following in detail a) Sensors and Actuators. b) Connecting Smart Objects.**