1. **What is the purpose of supervisor mode?**
   
   It is provided by CPU. This mode has privileges that user modes do not have. The ARM instruction that puts the CPU in supervisor mode is called SWI.

2. **State the functions of coprocessor.**
   
   These are attached to the CPU and implement some of the instructions. For example, floating-point arithmetic was introduced into the Intel architecture by providing separate chips that implement the floating-point instructions.

3. **Differentiate top-down and bottom-up design.**

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

4. **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.

5. **Enumerate various issues in real time computing.**
   
   - Complex algorithms
   - Complex user interface
   - Data must be ready by deadline
   - Multirate data to be handled
6. Write short notes on ARM processor.
   It is a family of RISC architectures that have been developed over many years. ARM7 is a Von Neumann architecture, while ARM9 is Harvard architecture. It is also a load – store architecture.

7. What are the instruction set features useful for embedded programming?
   - Fixed and Variable length instructions
   - Various addressing modes
   - Operand sizes must be variable
   - Different types of operations must be supported

8. What are the parameters used to evaluate the CPU performance?
   - Pipelining
   - Superscalar execution
   - Caching

9. What is function of exceptions?
   They are generally implemented as a variation of interrupt. Handlers are defined for different types of internal errors that can be generated.

10. How is ARM processor different from other processors?
    It is a family of RISC architectures that have been developed over many years. ARM7 is a Von Neumann architecture, while ARM9 is Harvard architecture. It is also a load – store architecture. It supports fast interrupt requests too.

11. When is Application Specific System processors (ASSPs) used in an embedded system?
    In computers, an ASSP (application-specific standard product) is a device integrated circuit product that is dedicated to a specific market and sold to more than one user (and thus, "standard"). The ASSP is to multiple customers just as a general-purpose product is, but to a smaller number of customers since it is for a specific application. Like an ASIC (application-specific integrated circuit), the ASSP is for a special application, but it is sold to any number of companies. (An ASIC is designed and built to order for a specific company.)
12. What are the various embedded system design model refining/partitioning techniques?
   - Abstract co-design finite-state machines
   - Extended co-design finite-state machines
   - Using Unified Modeling Language

13. What is an embedded computer system?
   An Embedded system is one that has computer hardware with software embedded in it as one of its most important component.
   The three main components of an embedded system are
   1. Hardware
   2. Main application software
   3. RTOS

14. Sketch the major levels of abstraction in the design process.

```
Requirements
  ↓
  Specification
  ↓
  Architecture
  ↓
  Components
  ↓
System Integration
```

15. Define Embedded systems.
   A Device that includes programmable computer but is not itself intended to be a general purpose computer is called as embedded computers. Eg: Fax, automobiles
16. Why Micro processors are used in embedded computing?
   - They are an efficient way to implement digital systems.
   - They make it easier to design families of products that can be built to provide various feature sets at different price points and can be extended to provide new features to keep up with rapidly changing market.

17. What are the characteristics of Embedded Systems?
   - Embedded computing system have to provide sophisticated functionality.
   - Embedded computing operation must be performed to meet deadlines.
   - Manufacturing cost and power consumption.

18. What are the challenges of Embedded Systems?
   - How much hardware do we need?
   - How do we meet deadlines?
   - How do we minimize power consumption?
   - How do we design for upgradeability?
   - Does it really work? - Complex Testing

   Requirements, Specification, Architecture, Components, System Integration.

20. What is meant by Harvard Architecture and Von – Neumann Architecture?
   In Von Neumann architecture the computer memory holds both data and instructions whereas Harvard machines holds separate memories for data and program.
PART – B

1. Name three mechanisms by which a CMOS microprocessor consumes power and also specify severe power saving strategies used in CMOS CPU’s. (8) [APR 2017]

2. What are the several requirements of an embedded computing system design. (8) [APR 2017]

3. How a branching and procedural does has been performed in ARM processor. (8) [APR 2017]

4. What are the ways of programming input and output devices in an embedded system design? (8) [APR 2017]

5. How CPU performance is affected? Explain them with example instructions. (8) [NOV 2016]

6. Analyze the requirements for designing GPS moving map in embedded system design process. (8) [NOV 2016]

7. How are the conceptual specifications and detailed specifications written in UML Language to design the model train controller? (8) [NOV 2016]

8. How memory management is done for an embedded system processor in order to manage multiple programs in single physical memory? (8) [NOV 2016]

9. Explain in detail the operation of ARM processor and coprocessor. (16) [NOV 2016]

10. With a simple system namely, a model train controller, how will you use the UML to model systems? (8)

11. Explain the operation of the BL instruction, including the state of ARM registers before and after its operations. (4)

12. How do you return from an ARM procedure? (4)

13. Draw the architecture of an ARM processor. Explain about the various blocks in detail.

14. (i) Explain about the evaluation of CPU performance.

(ii) State and explain various instructions set preliminaries.
UNIT II – EMBEDDED COMPUTING PLATFORM DESIGN

1. What is meant by control bus in a CPU?
   Control bus carries control signals R/W', Data Ready, Interrupt signals.

2. Can latches be used to construct input ports? Justify.
   Latches are level sensitive whereas flip flops are edge sensitive, if input ports are constructed using
   latches they become transparent to inputs when enabled and in most processors we write ‘1’ to the port
   to enable it which obviates the reason. So latches are a better choice for input ports.

3. What is the bus protocols especially, the four-cycle handshake?
   - Device 1 raises its output to signal an enquiry
   - When Device 2 is ready to receive, it sends acknowledgement
   - After data transfer Device 2 lowers its output
   - After seeing this release of acknowledgement, Device 1 lowers its output

4. What is a data flow graph?
   It is a model of a program with no conditionals.

5. What are CPU buses?
   It is a collection of wires and it defines a protocol by which the CPU, memory and devices
   communicate.

6. List out the various compilation techniques.
   Statement Translation, Dead code Elimination, Procedure Inlining, Loop Transformation, Register
   Allocation, Scheduling, Instruction Selection.

7. What are the different CPU buses? State the function of each one.
   Clock – For synchronization
   R/W' – Differentiates bus Read or Write operation
   Address – Bundle of signals that transmits the address of an access
   Data – Bundle of signals that carry data
   Data Ready’ – Signals when data on data bus is valid

8. State the principle of basic compilation techniques.
High level language code is parsed and symbol table is generated and is semantically analysed and machine independent optimizations are done, instruction level optimizations are performed and assembly codes are generated.

9. **Name any two techniques used to optimize execution time of a program.**
   Try to use registers efficiently and analyze cache behavior to avoid cache conflicts.

10. **What does a linker do?**
    The linker translates relative addresses into absolute addresses and produces an Executable Binary File.

11. **What are the four types of data transfer used in USB?**
    - Control Transfer
    - Isochronous Transfer
    - Interrupt Transfer
    - Bulk Transfer

12. **Give the limitations of polling technique.**
    Polling technique cannot be used for prioritizing the interrupt inputs, therefore high priority requests might remain pending while Low priority requests are being served.

13. **Comment on UML.**
    Unified Modeling Language is used to conceptualize the various steps of the design process as diagrams such as creating requirement and specifications, architecting the system, designing code and designing tests.

14. **Brief the term processes and threads.**
    A process is a program under execution but a single process can have several threads. Thread is a Light-Weight process.

15. **Define Bus protocol?**
    Bus protocol is a set of rules for communication between Processor, Memory and Devices.

16. **Name the types of RAM?**
    Static RAM and Dynamic RAM are the two major categories of RAM.
17. What is the difference between Timers and Counters?
   Timer has its count input connected to an periodic signal whereas Counter has its count input connected to an aperiodic signal.

18. Define Watch Dog Timer.
   It is an I/O device used for internal operation of a system. CPU’s software is designed to reset the watchdog timer periodically and prevents it from overflowing. If program hangs then this time overflows and resets the processor automatically.

19. Name the types of ROM.
   Factory Programmable ROM, Field Programmable ROM – Anti-fuse programmable ROM, UV Erasable PROM, Flash PROM.

20. What is handshaking in bus interface?
   Handshaking is a process of exchanging control signals in a systematic way so that data can be exchanged between two devices.

21. Define CISC and RISC.

<table>
<thead>
<tr>
<th>CISC</th>
<th>RISC</th>
</tr>
</thead>
<tbody>
<tr>
<td>It provides a number of addressing modes</td>
<td>It provides very few addressing modes</td>
</tr>
<tr>
<td>It has micro programmed unit with a control memory</td>
<td>It has a hardwired unit without a control memory</td>
</tr>
<tr>
<td>An easy compiler design</td>
<td>Complex compiler design</td>
</tr>
</tbody>
</table>

PART – B

1. Explain in detail about the compilation process in high level languages. (8) [APR 2017]
2. What are the program level performance analyses of embedded computing system design? (8) [APR 2017]
3. Discuss in detail the optimization of program size of an embedded system. (8) [APR 2017]
4. Discuss in detail various programming models. (8) [APR 2017]
5. Explain in detail the testing process involved in developing an embedded system. (8) [NOV 2016]
6. Describe how embedded system is useful in completing with computing platform. (8) [NOV 2016]
7. Explain the various debugging techniques in the development of embedded system. (8) [NOV 2016]
8. Discuss in detail the optimization of power and energy of an embedded system. (8) [NOV 2016]
9. Describe about memory devices with suitable examples. (16) [NOV 2016]
10. Discuss in detail about assembly and linking with examples. (16) [NOV 2016]
UNIT III - PROCESSES AND OPERATING SYSTEM

1. Give any two properties of an Operating System.
   - OS defines a job which has predefined sequence of commands, programs and data as a single unit.
   - OS keeps a number of jobs in memory and executes them without any manual information.

2. Define: Multitasking
   Multitasking is the process of running multiple tasks simultaneously in different ways. Examples are Co-routines, Cooperative Multitasking and Preemptive Multitasking.

3. What are the major inter process communication mechanisms?
   Shared Memory and Message Passing Mechanisms.

   Processes are programs under execution. There are two types Light Weight and Heavy Weight Processes.

5. What is context switching?
   Context switching is the mechanism for moving the CPU from one executing process to another. But the switch must be bug free.

6. List the process scheduling policies.
   Rate Monotonic and Earliest Deadline First Scheduling policies.

7. What are the power optimization strategies used for processes?
   - Power up the system when the request is received
   - Predictive Shutdown – Predict when the next request will arrive and start the System just in time.

8. What does a scheduler do in an operating system environment?
The scheduler decides which process has to be sent to the CPU next for execution.

9. Mention the uses of interrupt service routines?
When ever an interrupt occurs the Interrupt Service Routine is invoked which consists of the handler for the specific interrupt that occurs.

10. List the three conditions that must be satisfied by the re-entrant functions?
- The functions should not use variables in a non-atomic way
- The function should not call any other functions that are non re-entrant
- The function should not be non re-entrant by itself

11. Brief on predictive shut down.
Predictive Shutdown – Predict when the next request will arrive and start the system just in time to optimize power consumption.

12. What is meant by multirate systems?
In multirate systems, certain operations must be executed periodically and each operation is executed at its own rate.

13. Why is context Switching needed? List its types.
Context switching is the mechanism for moving the CPU from one executing process to another. But the switch must be bug free. Examples are- Cooperative Multitasking and Preemptive Multitasking.

14. Define the term scheduling in RTOS?
Scheduling is the mechanism by which tasks are dispatched to the processor according to any policy so that the process completes by its deadline.

15. How many states can a process be in? List them.
A process can be in any of the three scheduling states: waiting, ready, executing.

16. Mention the roles of Operating Systems?
When job completes its execution, its memory is released and the output for the job gets copied into an output spool for later printing or processing by the OS, it defines a task. Context switching is done without manual intervention.

17. **What is meant by Inter Process Communication?**

Processes often need to communicate with each other. Inter Process Communication is provided by the operating system as a part of process abstraction. A process can send either a blocking or a non-blocking communication.

18. **Write about Shared Memory Problem.**

Two CPUs share a common address location, each of them see that flag indicates ready, and both of them write to the same location leading to conflict. This problem can be solved by using semaphores.

19. **Why do you use infinite loop in embedded software?**

Embedded softwares run on real time systems which keep running continuously, just for instance an ATM machine can be considered which keeps waiting for a user to swipe his card, which is again an aperiodic process with unlimited inter arrival time. In such cases an infinite loop is used.

20. **What are Signals in operating systems?**

Signals are mechanisms used in operating systems for Inter Process Communication. It is analogous to an interrupt but is entirely a software creation. Eg: Signals is POSIX – SIGALRM, SIGPIPE, SIGILL, SIGSEGV.

**PART – B**

1. Explain with neat diagram inter process communication. (8) [APR 2017]
2. Explain in detail Earliest Deadline First Scheduling. (8) [APR 2017]
3. Explain the example real time operating system called POSIX in detail. (8) [APR 2017]
4. Explain in detail the Power Optimization Strategies in embedded system. (8) [APR 2017]
5. Describe Why automobile engines require a multirate control. (8) [NOV 2016]
6. Explain the example real time operating system called windows CE in detail. (8) [NOV 2016]
7. Explain in detail Rate Monotonic Scheduling with suitable examples. (8) [NOV 2016]
8. Discuss in detail about multi-tasking and multi-processing. (8) [NOV 2016]
9. Discuss any two Scheduling policies used in multiprocess environment. (16) [NOV 2016]
10. Discuss about multiple process and inter process communication mechanisms. (16) [NOV 2016]
UNIT IV - SYSTEM DESIGN TECHNIQUES AND NETWORKS

1. What are hardware accelerators?
These are a specific hardware attached to CPU buses to quickly execute certain functions. They can provide large performance increases for applications with computational kernels that spend a great deal of time in a small section of code.

2. State some of the networks dedicated for embedded systems.
I\(^2\)C, CAN and SHARC Link ports.

3. List the OSI layers from lowest to the highest level of abstraction.
Physical Layer, Data Link Layer, Network Layer, Transport Layer, Session Layer, Presentation Layer and Application Layer.

4. What is a distributed embedded architecture?
It is the organization of a distributed embedded system, its basic units are Processing Elements which can be instruction set processor or non programmable units also.

5. State the advantages of Network based design.
The jobs can be scheduled and allocated to processing elements based on their computation time and all the embedded networks are designed for low cost. One part of the system can be used to diagnose the other part.

6. What is the use of attaching accelerator to CPU?
These are a specific hardware attached to CPU buses to quickly execute certain functions. They can provide large performance increases for applications with computational kernels that spend a great deal of time in a small section of code.

7. State the important requirements to develop Network based embedded Systems.
- When the devices with which the PEs communicate are physically separated.
- The system has component subsystems that have their own embedded processors.
- To meet real time requirements.

8. **What are the merits of embedded distributed architecture?**
The jobs can be scheduled and allocated to processing elements based on their computation time and all the embedded networks are designed for low cost. One part of the system can be used to diagnose the other part of the system.

9. **What is the role played by the accelerator in the design of embedded system?**
Accelerators are designed to perform specific functions. We use the generic term Application Specific Integrated Circuit (ASIC).

10. **Differentiate counting semaphore and binary semaphore.**
    Counting Semaphore: It takes a count value of integer data type and every time it is taken the count is decremented and when it reaches zero the task is blocked.
    Binary Semaphore: It can take only 0/1, when taken it takes value of 1 and when released it takes value of 0.

11. **What is priority inheritance?**
    Priority Inheritance is the solution for Priority Inversion problem where a low priority task executes whereas a high priority task keeps waiting. When semaphores are taken the task that has taken the semaphore inherits the priority of the highest priority task that it blocks to avoid priority inversion.

12. **List the two ways of assigning priorities?**
    Fixed Priority and Dynamic Priority Schemes.

13. **What is SMTP & HTTP?**
    Simple Mail Transfer Protocol (SMTP) is an Internet standard for electronic mail (e-mail) transmission. First defined by RFC 821 in 1982, it was last updated in 2008 with the Extended SMTP additions by RFC 5321 - which is the protocol in widespread use today. SMTP by default uses TCP port 25.
The Hypertext Transfer Protocol (HTTP) is an application protocol for distributed, collaborative hypermedia information systems. HTTP is the foundation of data communication for the World Wide Web. Hypertext is structured text that uses logical links (hyperlinks) between nodes containing text.

14. **What is the use of Distributed Networks?**

   The jobs can be scheduled and allocated to processing elements based on their computation time and all the embedded networks are designed for low cost. One part of the system can be used to diagnose the other part of the system.

15. **Write the significance of stub code?**

   A stub is a small program routine that substitutes for a longer program, possibly to be loaded later or that is located remotely. For example, a program that uses Remote Procedure Calls is compiled with stubs that substitute for the program that provides a requested procedure. The stub accepts the request and then forwards it (through another program) to the remote procedure. When that procedure has completed its service, it returns the results or other status to the stub which passes it back to the program that made the request.

16. **List the names of Abstraction of Networks.**

   Physical Layer, Data Link Layer, Network Layer, Transport Layer, Session Layer, Presentation Layer and Application Layer.

17. **Write a note on CAN?**

   CAN bus (for controller area network) is a vehicle bus standard designed to allow Microcontroller and devices to communicate with each other within a vehicle without a Host Computer. CAN bus is a Message Based Protocol designed specifically for automotive applications but now also used in other areas such as aerospace, maritime, railway vehicles, industrial automation and Medical equipment.

18. **List the applications of CAN protocol.**

   - Automotive Applications
   - Industrial Applications
   - Entertainment
19. Mention the roles played by Ethernet, Internet and Myrinet.
   Ethernet is a widely used local area network for general purpose computing.
   Internet uses a fundamental protocol that provides connectionless packet based
   Communication.
   Myrinet is a high performance network that provides a full duplex connection.


   ![Ethernet Packet Format Diagram]

   **PART – B**

   1. Briefly explain about the quality assurance process taken place in the embedded computing system
design. (16) [APR 2017]
   2. With neat diagram explain the working of I2C. (8) [APR 2017]
   3. With neat diagram explain the working of CAN bus. (8) [NOV 2016]
   4. Briefly explain about the design methodologies for an embedded computing system. (16) [NOV 2016]
   5. Discuss in detail about the network based embedded system design. (8) [NOV 2016]
   6. Write short notes on internet enabled system. (8) [NOV 2016]
   7. Explain the accelerated system design process with suitable example. (16) [NOV 2016]
   8. Explain the working of CAN bus and Ethernet. (10) [NOV 2016]
   9. With suitable example explain the operation of Internet enabled system. (6) [NOV 2016]
   10. Explain about accelerators and accelerated system design with suitable diagrams. List
       its advantages.
UNIT V – CASE STUDY

1. **What do you mean by co-design?**
   
   The hardware and software must be designed together to make sure that the implementation not only functions properly but also meets the goals of performance, cost and reliability.

2. **What is a Set-top box. List out its advantages.**
   
   A set-top box or set-top unit is an information appliance device that generally contains a TV-tuner input and displays output connects to a television set and an external source of signal, turning the source signal into content in a form that can then be displayed on the television screen or other display device.

3. **What is PDA?**
   
   Short for personal digital assistant, a handheld device that combines computing, telephone/fax, Internet and networking features. A typical PDA can function as a cellular phone, fax sender, Web browser and personal organizer. PDAs may also be referred to as a palmtop, hand-held computer or pocket computer.

4. **Write short notes on H/W and S/W co-design.**
   
   It is a cooperative design of Hardware and Software. It deals with the design of heterogeneous systems. One of the goals is to shorten the time to market while reducing the design effort and cost of the designed products.

5. **List the various FOSS tools used for Embedded System development?**
   
   a. Shared Libraries
   
   b. Operating System Kernels – uClinux etc.,
c. Development tools – Compilers, Debuggers etc.,

6. List the major components in the Personal Digital Assistant system
   a. Screen Display
   b. Power Section (including Battery)
   c. Built in memory
   d. PDA Operating System / Software

7. What are FOSS tools?
   Free and open-source software (FOSS) is Computer Software that can be classified as both Free Software and Open Source Software. That is, anyone is freely licensed to use, copy, study, and change the software in any way, and the source code is openly shared so that people are encouraged to voluntarily improve the design of the software. This is in contrast to Proprietary Software, where the software is under restrictive Copyright and the source code is usually hidden from the users.

8. List the applications of PDA.
   a. Personal Information Management
   b. Store and retrieve addresses and phone numbers
   c. Maintain a calendar
   d. Create to-do lists and notes

9. Why do most designers use FOSS tools in embedded system development?
   a. Lots of ready to use components for most parts of the system. Lets you focus on the innovative part of your product, what differentiates it.
   b. You do not need to wait for months or years for some features to be implemented by others. At least, you can implement the critical ones that you need.
   c. Constant innovation. Features brought in at a quick pace, sometimes even before you need them!
   d. Possible to port Linux to a new innovative architecture. Easy to port your entire system then.

10. What is signal servicing function?
Signals are one form Inter Process Communication mechanisms where one process carries message to nearby process. It might be of one bit length and might not hold any information by itself.

11. Give the steps to destroy a message queue.
   In vxworks msqQDelete() function is used to eliminate the message queue by freeing the memory.

12. What are the functions of network layer and data link layer in network enabled systems.
   Network Layer defines the basic end to end data transmission service. It is important in multihop networks.
   The purpose of Data link layer is Error Detection and control over a single link.

13. Distinguish between coprocessor and multiprocessor.
   Co-processor is tightly coupled with the parent processor and performs specific designated functions.
   Multiprocessors are loosely coupled processors that are independent of each other in a distributed architecture.

14. What is the H/W and S/w Debugging?
   Hardware debugging is carried out using Logic Analyzer, In circuit emulator to check the correctness of the system.
   Software debugging is implemented using Breakpoints and CPU Simulators.

15. What is the Role of Set Top Box in Digital TV Systems?
   A set-top box is a device that enables a television set to become a user interface to the Internet and also enables a television set to receive and decode digital television (DTV) broadcasts. DTV set-top boxes are sometimes called receivers. A set-top box is necessary to television viewers who wish to use their current analog television sets to receive digital broadcasts. It is estimated that 35 million homes will use digital set-top boxes by the end of 2006, the estimated year ending the transition to DTV.

17. What are the Design Challenges of SOS?
   - Traditional Embedded System debugging becomes impractical.
   - Fabrication of chip takes weeks or months.
   - The circuit cannot be modified.
   - Fabrication is very expensive.
   - Observing signals is very difficult.

18. List the layers between application and hardware in PDA.
   There is a hardware and software platform between the application layer and underlying peripherals in
   PDA but there is no network layer functions in between.

19. What is an Application Specific Instruction Set processor?
   To meet highly specialized processing requirements in their SoCs, designers often turn to application
   specific instruction-set processors (ASIPs), which offer more architectural specialization as well a
   instruction and data–level parallelism compared to general-purpose processors.

20. Brief on the term “first-time correctness”.
   The cost of mistakes are very expensive in System – on – Silicon since fabrication itself takes a long
   time and the chances of debugging and monitoring signals is quite impractical therefore first-time
   correctness is aimed at.

PART – B

1. Write in detail about the embedded concepts in the design of engine control unit.(16) [APR 2017]
2. Explain the hardware and software design of digital still camera designed with automation of camera functions. (16) [APR 2017]
3. Explain the hardware and software design of software modem and telephone answering machine (16). [NOV 2016]
4. Write in detail about the embedded concepts in the design of data compressor and video accelerator. (16) [NOV 2016]
5. Write short notes on:
   (i) PDAs (8)
   (ii) Set-Top Box (8)
6. Enumerate some of the FOSS tools for embedded system development and explain. (16) [NOV 2016]
7. Describe in detail about the principle of operation of software modem.
8. What are FOSS tools for embedded system development? Explain the tools in detail.
9. Write a detailed note on the Software Modem with neat sketches.
10. Explain about the embedded hardware and software co-design.
11. Explain the hardware and software design of Set-Top Box.