1. Define the following concepts:

(a) Networked Application

An application that consists of a collection of processes (executing programs) executing on a collection of machines and communicating through a network.

(b) Network Server

A program that is part of a collection of programs that comprise a networked application. Typically, a network server waits at a well-known address and port for other programs, called the network clients, to send it requests for service. The server performs computations necessary to service the requests and sends responses or replies back to the clients.

(c) Network Client

A program that is part of a collection of programs that comprise a networked application. See the description of a network server above.

2. Define the concept of network protocol.

A network protocol is a set of rules that govern the format and meaning of the messages exchanged by processes communicating via a network.

3. Explain the following concepts, and give an example of each

(a) Application Layer protocol

A network protocol that carries messages that define the operations that a network application is supposed to carry out. Application layer protocols are the highest protocol in a protocol stack, and differ from lower layer protocols in the stack in that the lower layer protocols are concerned with network communication tasks, while application layer protocols are concerned with operations that the end user wants to perform.

HTTP (Hypertext Transfer Protocol) is an application protocol for communication between web servers and web clients.

FTP (File Transfer Protocol) is an application protocol used to transfer files between machines.

SMTP (Simple Mail Transfer Protocol) is an application protocol used to transfer mail between mail servers on the Internet.

(b) Transport Layer protocol
A transport layer protocol is concerned with carrying messages from one network process to another. The protocol allows two processes to communicate regardless of the application layer protocol the processes are using.

An TCP (Transmission Control Protocol) and UDP (User Datagram Protocol) are the two main transport layer protocols used on the Internet.

(c) Network Layer protocol

A network layer protocol carries network messages from one machine to another. Network layer protocols differ from transport layer protocols in that while the transport layer connects processes, the network layer connects machines.

IP (Internet Protocol) is an example of a network layer protocol.

4. Explain the role played by the IP address and port number in the working of networked applications, and identify the port that is used by default by web applications.

In network communication on the Internet, the IP address is used to identify machines on the Internet while port numbers are used to identify a particular application running on the machine. On the Internet, IP addresses correspond to domain names of machines: for example, www.ibm.com or www.noctrl.edu.

By default, web servers run at port 80.

5. How does a web application differ from a more generic network application?

A web application is a networked application that uses HTTP for its application layer protocol.

6. Early web applications used a concept called CGI. Explain what the initials stand for, and explain in some details how web servers used CGI.

CGI stands for Common Gateway Interface. CGI is an interface that a webserver can use to exchange information with a program running on the same machine as the web server.

CGI applications are written to get their input from their program environment and from standard input, and to send their output to their standard output. When the web server receives a request for a CGI application, the server creates a process to run the CGI program and passes it the request.

A web server passes a HTTP request to a CGI application by using the program environment for parameters in the query string, and by writing the body of the request to the CGI program’s standard input. The web server then reads the response from the program’s standard output and forwards the response back to the web client.

7. Define the concept of servlet, and explain how it differs from, and any advantages that a servlet has over, CGI.
A servlet is a Java object that receives requests over the network and generates responses to those requests. A HTTP servlet is a servlet that receives HTTP requests and generates HTTP responses. Servlets run inside of a Java execution environment called a servlet container. The servlet container passes the request to the servlet by calling the servlet’s service method in a thread. In this way, the same servlet object can be used to simultaneously service multiple requests.

The use of threads is more efficient than CGI, because with CGI, the web server has to create a different process for each request.

8. Explain the concepts of URL, URI, and URN, pointing out both the relation among the three concepts, as well as the differences.

URI stands for Uniform Resource Identifier; URL stands for Uniform Resource Locator, and URN stands for Uniform Resource Name.

URI is a sort of general abstract concept: a URI is either a URL or a URN. URLs actually give the location of a resource on the Internet. A URN is supposed to identify a resource with just a name, apart from giving location information. Most URIs used today are URLs.

9. Explain POST and GET HTTP methods, pointing out both the similarities and differences.

The main difference is that a request using POST has a body that is used to submit data collected from forms, while a request using GET sends the form data as part of a query string appended to the end of the URL.

There are other differences in the intended usage of the two methods. For example, The protocol suggests that GET be used when the request will not change the state of the server, and that POST be used when the request changes the server’s state. Both of these suggestions are often violated in practice.

10. HTTP requests sent from a web client to a web server follow a certain format that has a first part, followed by a second part, followed by a blank line, and an optional third part.

What is the first part called, and what components are in the first part?

The first part is the request line. The request line specifies a HTTP request method, a request URL, and the HTTP version being used.

What components are in the second part?

The second part consists of the request headers. This is a sequence of name value pairs providing additional information about the request.
What components are in the third part, when it is present?

*If present, the third part of the body of the message. It consists of parameter value pairs gathered from data entered by the user into a form.*

11. Give two examples of a HTTP request header, and explain the purpose of those headers.

- **accept**: Specifies the preferred order of MIME types that the browser can accept.
- **referer**: Specifies the URL of the referring page.
- **user-agent**: Indicates the type of browser sending the request.

12. HTTP responses also have three parts. Identify each of the three parts. Be sure to explain the purpose or function of each part as you explain it.

- **Status Line**: consists of the HTTP version used by the response, a status code indicating the success of the request, or the reason for the failure of the request, and an explanatory phrase that details the meaning of the status code.
- **Response Headers**: A list of name value pairs providing additional information about the response.
- **Message Body**: The body of the message.

13. There are three main web application technologies used on the client-side to construct user interfaces and make them work. State each of the three technologies, and explain the role played by each technology.

- **HTML**: This is used to present content to the client.
- **CSS**: This is used to style the content, determining how it looks.
- **JavaScript**: This is a programming language embedded in the browser used to execute actions on the client side. The actions may manipulate the content in different ways, or validate input entered in forms before it is submitted to the server.

14. Give examples of at least 3 HTML tags and explain their function.

- `<p>`: Used to enclose a paragraph of text.
- `<form>`: Used to enclose user interface input elements that hold data entered by the user for submission to the server.
- `<script>`: Used to enclose a script of code to be executed on the client.

15. HTML input tags typically appear in forms and can have attributes. Give the name of the attribute used to access the value in an input element on the server-side. Also, give the name of the attribute used to uniquely identify HTML elements on the client-side.
NAME: provides a handle by which data entered into an element will be accessed on the server-side.

ID: provides a way of uniquely identifying an input element or HTML tag on the client side.

16. What is the purpose of CSS style sheets? Also, identify the three types of style sheets explain the differences among the three, and note the priority of application in situation when more than one style sheet applies.

CSS style sheets are used to specify how the content of various HTML tags should be rendered.

In increasing order of priority, the three types of style sheets are:

(a) external style sheet: these can be used to specify style for many HTML documents. Each HTML document that wants to use the style places a link to the style sheet in a `<style>` element in the head element of the document.

(b) internal or document style sheet: This is used to apply a collection of style rules to an entire document. The style sheet itself, not just a link, is placed in the header element of the document.

(c) in-line style sheet: the style rule is placed as the value of the `style` attribute of the HTML tag. Applies only to the content of that tag.

17. What purpose does the form element serve in a HTML document? Explain. In your explanation, identify the two most important attributes of the form element and point out their purpose.

A form element encloses input elements into which the user can enter data for submission to the server.

The most important attributes of the form are the Method and Action attributes. The Method attributes specifies how the form data is to be submitted to the server, and the Action attribute specifies the URL to which the data is submitted.

18. HTML documents sometimes have a hidden input element that is never visible to the user, and therefore can never be used to get input from the user. Explain its purpose, and give an example of how the hidden input element can be used.

The hidden input element can be used by the server to embed information useful to the server, but which the user does not need to see. The embedded information is then available to the server when the next request is submitted from the client. Hidden inputs are a way of carrying information across HTTP requests.