MA8352/LINEAR ALGEBRA AND PARTIAL DIFFERENTIAL EQUATIONS

UNIT I
VECTOR SPACES
PART- A

1. Define vector spaces.

A vector space is a set V on which two operations + and · are defined, called vector addition and

Scalar multiplication. The operation + (vector addition) must satisfy the following conditions:

Closure: If u and v are any vectors in V, then the sum u + v belongs to V.

(a)Commutative law: For all vectors u and v in V, u + v = v + u

(b)Associative law: For all vectors u, v, w in V, u + (v + w) = (u + v) + w

(c)Additive identity: The set V contains an additive identity element, denoted by 0, such that for any vector v in V, 0 + v = v and v + 0 = v.

(d)Additive inverses: For each vector v in V, the equations v + x = 0 and x + v = 0 have a solution x in V, called an additive inverse of v, and denoted by - v.

The operation · (scalar multiplication) is defined between real numbers (or scalars) and vectors, and must satisfy the following conditions: Closure: If v in any vector in V, and c is any real number, then the product c ·v belongs to V.

(e)Distributive law: For all real numbers c and all vectors u, v in V, c · (u + v) = c ·u + c ·v

(f)Distributive law: For all real numbers c, d and all vectors v in V, (c+d) ·v = c ·v + d ·v

(g)Associative law: For all real numbers c,d and all vectors v in V, c · (d ·v) = (cd) ·v

(h)Unitary law: For all vectors v in V, 1 ·v = v

2. Write down the two properties of Vector spaces.

(i). Addition: If u and w belong to V then so does u + w.

(ii). Scalar Multiplication: If u belongs to V, then so does k u for all arbitrary scalars k.

3. Define Subspaces of vector spaces.

Let V be a vector space, and let W be a subset of V. If W is a vector space with respect to the Operations in V, then W is called a *subspace* of V.

4. Write down the example of vector subspace.

Consider all possible solutions to the homogeneous system Ax = 0. If x_1 and x_2 are two solutions then is $x_1+ x_2$, as A ($x_1+ x_2$) = A x_1+ A x_2 = 0 + 0 = 0.Similarly, if x is a solution, then so is k x. As a result, all the possible solutions to Ax =0 constitute a vector space called the solution space.

5. Define Linear Combinations.

Let $\overrightarrow{v_1}, \overrightarrow{v_2}, \ldots\ldots \overrightarrow{v_n}$ be any vectors in a vector space Vand let $c_1, c_2, \ldots, c_n$be any set of scalars. Then an expression of the form $c_1\overrightarrow{v_1} + c_2\overrightarrow{v_2} + \ldots\ldots\ldots + c_n\overrightarrow{v_n}$ is called a linear combination of the vectors.

6. What is the definition of span of vector space?

The set S that contains all possible linear combinations of $\overrightarrow{v_1}, \overrightarrow{v_2}, \ldots\ldots \overrightarrow{v_n}$ is called the spanof $\overrightarrow{v_1}, \overrightarrow{v_2}, \ldots\ldots \overrightarrow{v_n}$ .We frequently say that S is spanned (or generated) by those n vectors.

7. Define linearly independent vector space.

Given a set of vectors $\overrightarrow{v_1}, \overrightarrow{v_2}, \ldots\ldots \overrightarrow{v_n}$ from a vector space V. This set is called linearly independent in V if the equation $c_1\vec{v_1} + c_2\vec{v_2} + \dots\dots\dots + c_n\vec{v_n}$ = 0. Implies that c_i = 0 for all i = 1, 2,...... n.

8. Define linearly dependent vector space.

If a set of vectors is not linearly independent, then it is called linearly dependent. This implies that the equation above has a nonzero solution, that is there exist $c_1, c_2, \dots\dots c_n$ which are not all zero, such that $c_1\vec{v_1} + c_2\vec{v_2} + \dots\dots\dots + c_n\vec{v_n}$ = 0. This implies that at least one of the vectors $\vec{v_i}$ can be written in terms of the other n − 1 vectors in the set.

9.What is the definition ofBasis of a Vector Space?

Let V be a vector space over F with V ≠ {0}. Then a maximal linearly independent subset of V is called a basis of V. The vectors in a basis are called basis vectors. Note that a basis of {0} is either not defined or is the empty set.

10. DefineDimension of a Vector Space.

Let V be a vector space over F with V ≠ {0}. Suppose V has a finite maximal linearly independentset S. Then | S | is called the dimension of V. By convention, dim({0}) = 0.

11. What is maximal subset.

Let S be a subset of a set T. Then S is said to be a maximal subset of T having property P if

1. S has property P and
2. no proper superset S of T has property P.

12. Define maximal linearly independent vector space.

Let V be a vector space over F. Then S is called a maximal linearly independent subset of V if

1. S is linearly independent and
2. No proper superset S of V linearly independent

13. Define minimal spanning.

Let V be a vector space over F with V≠ {0}. Then a set S ⊆ V is called minimal spanning if LS(S) = V and no proper subset of S spans V.

14. Determine whether the vectors $v_1 = \begin{pmatrix} 1 \\ -2 \\ 3 \end{pmatrix}$, $v_2 = \begin{pmatrix} 5 \\ 6 \\ -1 \end{pmatrix}$, $v_3 = \begin{pmatrix} 3 \\ 2 \\ 1 \end{pmatrix}$ **are linearly independent or not.**

$$\text{Let } c_1v_1 + c_2v_2 + c_3v_3 = \begin{pmatrix} 1 \\ -2 \\ 3 \end{pmatrix}c_1 + \begin{pmatrix} 5 \\ 6 \\ -1 \end{pmatrix}c_2 + \begin{pmatrix} 3 \\ 2 \\ 1 \end{pmatrix}c_3 = \begin{pmatrix} 0 \\ 0 \\ 0 \end{pmatrix}$$

Hence, they are linearly dependent.

15. Let $v_1 = \begin{pmatrix} 1 \\ -1 \\ 0 \end{pmatrix}$, $v_2 = \begin{pmatrix} -2 \\ 3 \\ 1 \end{pmatrix}$, $v_3 = \begin{pmatrix} 1 \\ 2 \\ 4 \end{pmatrix}$. **Determine whether these vectors span R^3.**

$$\text{Let } c_1v_1 + c_2v_2 + c_3v_3 = \begin{pmatrix} 1 \\ -1 \\ 0 \end{pmatrix}c_1 + \begin{pmatrix} -2 \\ 3 \\ 1 \end{pmatrix}c_2 + \begin{pmatrix} 1 \\ 2 \\ 4 \end{pmatrix}c_3 = \begin{pmatrix} 1 & -2 & 1 \\ -1 & 3 & 2 \\ 0 & 1 & 4 \end{pmatrix}\begin{pmatrix} c_1 \\ c_2 \\ c_3 \end{pmatrix} = \begin{pmatrix} x_1 \\ x_2 \\ x_3 \end{pmatrix}$$

The augmented matrix $A=\begin{pmatrix} 1 & -2 & 1 & x_1 \\ -1 & 3 & 2 & x_1+x_2 \\ 0 & 1 & 4 & x_3-x_1-x_2 \end{pmatrix}$

Therefore the solution exists and hence the vectors span R^3.

16. Define Finite Dimensional Vector Space.

Let V be a vector space over F. Then V is called finite dimensional if there exists S ε V, such that
S has finite number of elements and V = LS(S). If such an S does not exist then V is called infinite dimensional.

17. Is the set S = $\{(1, 2, 1)^T, (2, 1, 4)^T, (3, 3, 5)^T\}$ **a linear independent set? Give reasons.**

Consider the system a(1, 2, 1) + b(2, 1, 4) + c(3, 3, 5) = (0, 0, 0) in the unknowns a, b and c. As rank of coefficient matrix is 2 < 3, the number of unknowns, the system has a non-trivial solution. Thus, S is a linearly dependent subset of R^3.

18.Is the set S ==$\{(1, 1, 1)^T, (1, 1, 0)^T, (1, 0, 1)^T\}$ **a linear independent set? Give reasons.**

Consider the system a(1, 1, 1) + b(1, 1, 0) + c(1, 0, 1) = (0, 0, 0) in the unknowns a, b and c. As rank of coefficient matrix is 3 = the number of unknowns, the system has only the trivial solution. Hence, S is a linearly independent subset of R^3.

19. Is the set S = {1, i} **a linear independent set? Give reasons.**

Since C is a complex vector space, i · 1 + (−1)i = i − i = 0. So, S is a linear dependent subset the complex vector space C.

20. Define Ordered Basis, Basis Matrix.

Let V be a vector space over F with a basis B = $\{u_1, \ldots, u_n\}$. Then an ordered basis for V is a basis B together with a one-to-one correspondence between B and {1, 2, . . . , n}. Since there is an order among the elements of B, we write B = $[u_1, \ldots, u_n]$. The matrix B = $[u_1, \ldots, u_n]$ is calledthe basis matrix.

21. What is the meaning of Basis?

A set of vectors $\{\vec{v_1}, \vec{v_2}, \ldots \vec{v_n}\}$ in a vector space V is said to be a Basis for V provided that it is both a linearly independent set and a spanning set for V.

22.Give an example of Basis.

Let V = F^n where F =R or C and let e_i€V be the n-tuples which has I in the i-th place and zero elsewhere. Then $\{e_1, e_2, \ldots e_n\}$ is a basis for V as a vector space over F.It is usually known as the Standard Basis for F^n.

23.State Replacement lemma.

Let$\{w_1, w_2, \ldots w_n\}$ be a basis of the finite-dimensional vector space V over F. Let v be any non-
zero vector in V.Then there exist w_i such that if we replace w_i by v then we still have a basis of V.

24.State Basis theorem.

Let V be a finite-dimensional vector space over F. All bases of V have the same number of elements.

25. Give an example of finite-dimensional vector space.

The vector space of all polynomials of degree at most 6 which has dimension 7. A basis for this
space is $\{1, x, x^2, x^3, x^4, x^5 x^6\}$.

PART – B

1. (a) Let V be the set of of all 2X2 matrices with real entries. Show that V is a vector space over R with respect to usual matrix addition done entry wise and usual scalar multiplication done entry wise. Verify all the conditions of a vector space.**(8)**

(b) Let V be a vector space over F. Then (i). u . v = u implies v = 0.(ii). α . u = 0 if and only if either u = 0 or α = 0.(iii). (−1) . u = −u, for every uεV.**(8)**
2. (a) Verify whether or not the set of all 2x2 real symmetric matrices forms a vector space over R?**(8)**
(b) If V is a set of all nxn matrices over any field F, then a set W of all nxn symmetric matrices forms a vector subspace of V(F).**(8)**
3. (a) Let V be a vector space over F and S ε V. Then Prove that LS(S) is a subspace of V.**(8)**
(b) Let V(F) be a vector space and W ε V,W $\neq$ φ. Then W is a subspace of V if and only if αu + βv εW whenever α, β ε F and u, v ε W.**(8)**
4. (a)Let V be a vector space over F and SεV. Then prove that LS(S) is the smallest subspace of V taining S.**(8)**
(b) Prove that the linear span L(S) of a subset S of a vector space (V, +,.) over M is a vector subspace of V. Further, show that L(S) is the smallest subspace that contains S.**(8)**
5. (a)Compute the fundamental subspaces for A = $\begin{pmatrix} 1 & 1 & 1 & -2 \\ 1 & 2 & -1 & 1 \\ 1 & -2 & 7 & -11 \end{pmatrix}$ **(8)**
(b) Let B = $\{\vec{v_1}, \vec{v_2}, \ldots \vec{v_n}\}$ be a subset of a vector space V. Then B is a basis if and only if each $\vec{v}$ € Vcan uniquely be expressed as a linear combination of vectors of B.**(8)**
6. (a) For what values of m,the vectors (m,3,1) is a linear combination of vectors e_1 = (3,2,1), e_2= (2, 1, 0).**(8)**
(b) Show that the vectors α_1 = (1, 0,-1),α_2 = (1, 2, 1),α_3 = (0,-3, 2) forms a basis for V_3(R).Express Each of the standard basis vectors as linear combination of α_1,α_2 and α_3.**(8)**
7. (a) Let S be a linearly independent set in a vector space V over F. Then each v ε LS(S) is a unique linear combination vectors from S.**(8)**
(b) Let V be a vector space over F. Let S = {u_1. . . u_k} ε V with S $\neq$ φ. If T ε LS(S) such that m = | T |> k then prove that T is a linearly dependent set.**(8)**
8. (a) Let V be a vector space over F and let S be a linearly independent subset of V. Suppose v ε V.
Then S intersection {v} is linearly dependent if and only if v ε LS(S).**(8)**
(b)Let V $\neq$ {0} be a vector space over F. Then the following statements are equivalent. (i). B is a
basis (maximal linearly independent subset) of V. (ii). B is linearly independent and it spans V. (iii). B is a minimal spanning set of V.**(8)**

9. (a)Let V be a vector space over F and let S and T be two finite maximal linearlyindependent Subsets of V. Then prove that | S | = | T |.**(8)**
(b) Let V be a vector space over F with dim(V) = n. If S is a linearlyindependent subset of V then
there exists a basis T of V such that S U T.**(8)**
10. (a) Determine whether or not the set S = { 1 + 2x + x^2 ,3 + x^2 , x + x^2 } forms a basis for P_2 (R).**(8)**
(b)State and prove Replacement Lemma.**(8)**
11. (a) State and prove Basis theorem.**(8)**
(b) Find a basis of R^3containing the vector $(1, 1, -2)^T$.**(8)**
12. (a)Find a basis of R^3containing the vector $(1, 1,-2)^T$and $(1, 2,-1)^T$.**(8)**
(b) Show that B = {$(1, 0, 1)^T$, $(1, i, 0)^T$, $(1, 1, 1 - i)^T$} is a basis of C^3over C.**(8)**
13. (a) Determine a basis and dimension of W = {$(x, y, z,w)^T$∈ R^4 | x + y − z + w = 0}.**(8)**
(b)Let $W_1$and W_2be two subspaces of a vector space V such that $W_1 \subseteq W_2$. Show that

$W_1 = W_2$ if and only if $\dim(W_1) = \dim(W_2)$. **(8)**

14. (a) Prove that $B = \{1, x, \ldots, x^n, \ldots\}$ is a basis of R[x]. B is called the standard basis of R[x]. **(8)**

(b) Let V be a vector space of dimension n. Then any set

(i) Consisting of n linearly independent vectors forms a basis of V.

(ii) S in V having n vectors with LS(S) = V forms a basis of V. **(8)**

15. (a) Let W_1 and W_2 be 4-dimensional subspaces of a vector space V of dimension 7. Then Prove that $\dim(W_1 \cap W_2) \geq 1$. **(8)**

(b) Let W1 and W2 be two subspaces of a vector space V. If dim(W1) + dim(W2) >dim(V), then prove that $\dim(W_1 \cap W_2) \geq 1$. **(8)**

UNIT – II

LINEAR TRANSFORMATION AND DIAGONALIZATION

PART-A

1. Define Linear Transformation.

Let V and W be vector spaces over F. A function (map) $T : V \to W$ is called a linear transformation if for all $\alpha \in F$ and $u, v \in V$ the function T satisfies $T(\alpha \cdot u) = \alpha . T(u)$ and $T(u + v) = T(u) + T(v)$, where +, · are binary operations in V and +, . are the binary operations in W.

2. What is InverseLinear Transformation?

Let V and W be two vector spaces over F and let $T \in L(V,W)$. If T is one-one and onto then $T^{-1} \in L(W, V)$, where $T^{-1}(w) = v$ whenever $T(v) = w$. The map T^{-1} is called the inverse of the linear transformation T.

3. Define Equality of Linear Transformation.

Let $S, T \in L(V,W)$. Then, S and T are said to be equal if $T(x) = S(x)$, for all $x \in V$.

4. Define singular and non- singular vector space.

Let V and W be two vector spaces over F and let $T \in L(V,W)$. Then, T is said to be singular if there exists $v \in V$ such that $v \neq 0$ but $T(v) = 0$. If such a $v \in V$ does not exist then T is called non-
singular.

5. Defineisomorphism.

Let V and W be two vector spaces over F and let $T \in L(V,W)$. Then, T is said to be an isomorphism if T is one-one and onto. The vector spaces V and W are said to be isomorphic, denoted $V \cong W$, ifthere is an isomorphism from V to W.

6. Define Matrix of the linear transformation.

Let $B = [v_1, \ldots, v_n]$ and $C = [w_1, \ldots, w_m]$ be ordered bases of V and W, respectively. If $T \in L(V,W)$
then the matrix T[B, C] is called the coordinate matrix of T or the matrix of the linear transformation T with respect to the basis B and C, respectively. When there is no mention of bases, we take the standard bases and denote the matrix by [T].

7. Let $B = [e_1,e_2]$ and $C = [e_1+e_2,e_1-e_2]$ be two ordered bases of R^2. Then compute T[B,B] and
T[C,C], where $T((x,y)^T = (x+y,x-2y)^T$

Let A = Id_2 and B = $\begin{bmatrix} 1 & 1 \\ 1 & -1 \end{bmatrix}$. Then $A^{-1} = Id_2$ and $B^{-1} = \frac{1}{2}\begin{bmatrix} 1 & 1 \\ 1 & -1 \end{bmatrix}$.

$$T[B,B] = \left[\left[T\left(\begin{bmatrix}1\\0\end{bmatrix}\right)\right]_B, \left[T\left(\begin{bmatrix}0\\1\end{bmatrix}\right)\right]_B\right] = \left[\begin{bmatrix}1\\1\end{bmatrix}_B, \begin{bmatrix}1\\-2\end{bmatrix}_B\right] = \begin{bmatrix}1 & 1\\1 & -2\end{bmatrix}$$ and

$$T[C,C]=\left[\left[T\left(\begin{bmatrix}1\\1\end{bmatrix}\right)\right]_C,\left[T\left(\begin{bmatrix}1\\-1\end{bmatrix}\right)\right]_C\right]=\left[\begin{bmatrix}2\\-1\end{bmatrix}_C,\begin{bmatrix}0\\3\end{bmatrix}_C\right]=\begin{bmatrix}\frac{1}{2} & \frac{3}{2}\\ \frac{3}{2} & -\frac{3}{2}\end{bmatrix}$$

As $\begin{bmatrix}2\\-1\end{bmatrix}_C = B^{-1}\begin{bmatrix}2\\-1\end{bmatrix} and \begin{bmatrix}0\\3\end{bmatrix}_C = B^{-1}\begin{bmatrix}0\\3\end{bmatrix}$

8. Let T $\in L$ (R^3,R^2) be defined by T($(x,y,z)^T$) = $(x+y-z,x+z)^T$. Determine [T].

Using definition,

$$[T] = [[T(e_1],[T(e_2)],[T(e_3)]] = \left[\begin{bmatrix}1\\1\end{bmatrix},\begin{bmatrix}1\\0\end{bmatrix},\begin{bmatrix}-1\\1\end{bmatrix}\right]=\begin{pmatrix}1 & 1 & -1\\1 & 0 & 1\end{pmatrix}$$

9. Does there exist a linear transformation T : $R^2 \rightarrow R^2$ such that T($(1, 1)^T$) = $(1, 2)^T$ and T($(5, 5)^T$) = $(5, 10)^T$?

Yes, as $(5, 10)^T = T((5, 5)^T) = 5T((1, 1)^T) = 5(1, 2)^T = (5, 10)^T$.

let $\{(1, 1)^T, u\}$ be a basis of R^2 and define $T(u) = v = (v_1, v_2)^T$, for some v ε R^2 .

For example, if u = $(1, 0)^T$ then $T\left(\begin{bmatrix}x\\y\end{bmatrix}\right)=T\left(\begin{bmatrix}1 & 1\\1 & 0\end{bmatrix}\left(\begin{bmatrix}1 & 1\\1 & 0\end{bmatrix}^{-1}\begin{bmatrix}x\\y\end{bmatrix}\right)\right)=y\begin{bmatrix}1\\2\end{bmatrix}+(x-y)v$

10. Does there exist a linear transformation T : $R^2 \rightarrow R^2$ such that Null(T) = {x ε R^2 | T(x) =0} = LS{$(1, \pi)^T$ }?

Yes. Let a basis of $R^2 = \{(1, \pi)^T, (1, 0)^T\}$ and define $T((1, \pi)^T) = 0$ and $T((1, 0)^T) = u \neq 0$.

11. State Reisz Representation Theorem.

Let T ε L(R^n , R). Then, there exists a ε R^n such that $T(x) = a^T x$.

12. What is the Sum and Scalar Multiplication of Linear Transformations?

Let V,W be vector spaces over F and let S, T ε L(V,W). Then, we define the point-wise

(i) sum of S and T, denoted S + T, by (S + T)(v = S(v) + T(v), for all v εV.

(ii) scalar multiplication, denoted cT for c ε F, by (cT)(v = c (T(v)), for all v ε V.

13. Define Range Space and Null Space

Let V and W be two vector spaces over F and let T ε L(V,W). Then, we define

(i) Rng(T) = {T(x) | x ε V} and call it the range space of T and

(ii) Null(T) = {x ε V | T(x) = 0} and call it the null space of T.

14. Determine Rng(T) and Null(T) of T ε L(R^3 , R^4), where we define T($(x, y, z)^T$) = $(x - y + z, y - z, x, 2x - 5y + 5z)^T$.

Consider the standard basis $\{e_1, e_2, e_3\}$ of R^3 . Then

Rng(T) = LS($T(e_1), T(e_2), T(e_3)$) = LS($(1, 0, 1, 2)^T$,$(-1, 1, 0, -5)^T$,$(1, -1, 0, 5)^T$)

= LS ($(1, 0, 1, 2)^T$,$(1, -1, 0, 5)^T$)

= $\{\lambda(1, 0, 1, 2)^T + \beta(1, -1, 0, 5)^T \mid \lambda, \beta \in R\}$

= $\{(\lambda + \beta, -\beta, \lambda, 2\lambda + 5\beta) : \lambda, \beta \in R\}$

= $\{(x, y, z, w)^T \in R^4 \mid x + y - z = 0, 5y - 2z + w = 0\}$

and Null(T) = $\{(x, y, z)^T \varepsilon R^3 : T((x, y, z)^T) = 0\}$

= $\{(x, y, z)^T \varepsilon R^3 : (x - y + z, y - z, x, 2x - 5y + 5z)^T = 0\}$

= $\{(x, y, z)^T \varepsilon R^3 : x - y + z = 0, y - z = 0, x = 0, 2x - 5y + 5z = 0\}$

= $\{(x, y, z)^T \varepsilon R^3 : y - z = 0, x = 0\} = \{(0, y, y)^T \varepsilon R^3 : y \varepsilon R\}$

= LS((0, 1, 1)T

15. Define Rank and Nullity.

Let V and W be two vector spaces over F. If T ε L(V,W) and dim(V) is finite then we define Rank(T) = dim(Rng(T)) and Nullity(T) = dim(Null(T))

16. State Rank-Nullity Theorem.
Let V and W be two vector spaces over F. If T εL(V,W) and dim(V) is finite then Rank(T) + Nullity(T) = dim(Rng(T)) + dim(Null(T)) = dim(V)
17. What is left inverse?
Let f : S → T be any function. Then, a function g : T → S is called a left inverse of f if (g ◦ f)(x) = x, for all x ε S. That is, g ◦ f = Id, the identity function on S.
18. What is right inverse?
Let f : S → T be any function .Then, a function h : T → S is called a right inverse of f if (f ◦ h)(y) = y, for all y ε T. That is, f ◦ h = Id, the identity function on T.
19. Define invertible.
Let f : S → T be any function .Then f is said to be invertible if it has a right inverse and a left Inverse.
20. Is (4, 5, 5) a linear combination of (1, 0, 0), (2, 1, 0), and (3, 3, 1)?
(4, 5, 5) is a linear combination if the linear system a(1, 0, 0) + b(2, 1, 0) + c(3, 3, 1) = (4, 5, 5) -----(1)
In the unknowns a, b, c ∈ R has a solution. Clearly, Equation (1) has solution a = 9, b = −10 and c = 5.
21. What is Matrix of a Linear Transformation?
Let B = $[v_1, \ldots, v_n]$ and C =$[w_1, \ldots ,w_m]$ be ordered bases of V and W, respectively. If T εL (V, W)
then the matrix T[B, C]is called the coordinate matrix of T or the matrix of the linear transformation T withrespect to the basis B and C, respectively.
22. State cayley-Hamilton theorem.
Any nxn matrix A is annihilated by its characteristic polynomial, that is $P_A(A)$= 0 for any A€M_n(C).
23. Define Matrix Digitalization.
A matrix A is said to be diagonalizable if A issimilar to a diagonal matrix. Or equivalently, $P^{-1}AP = D \Rightarrow AP = PD$, for some diagonalmatrix D and invertible matrix P.
24. Define Diagonalizable matrices.
LetA€M_n(F) where F = R or C .The matrix A is said to be Diagonalizable over F if there exist
matrices S€M_n(F),D €M_n(F) with S invertible diagonal and $S^{-1}AS = D$.
25. State Schur's unitary triangularization theorem.
Let A €M_n(C). Then there existsa unitary matrix U such that A is an upper triangular matrix. Further, if A €M_n(R) and σ(A)have real entries then U is real orthogonal matrix.

<u>PART – B</u>

1. (a) Let T:V→W be a linear transformation.Then T(v)={T(v)/v∈V} is a subspace of W.**(8)**
(b) Let V and W be vector spaces over a field F and T:Vv/v→W be a linear transformation. Then
the kernel of T is defined to be {v∈V and T(v)=0} and is denoted by ker T.Thus
ker T={v/v∈V and T(v)=0}. **(8)**
2. (a)Let V and W be vector spaces over a field F.Let L(V,W) represent the set of all linear transformations from V to W.Then L(V,W) itself is a vector space over F under addition and scalar multiplication defined by (f+g)(v)=f(v)+g(v) and(α f)(v)=α f(v).**(8)**
(b) Let V be a vector space over a field F.Let S,T$\subseteq$V,then (i) $S \subseteq T \Rightarrow L(S) \subseteq L(T)$.
(ii) $L(S \cup T) = L(S) + L(T)$. (c) $L(S) = S$ iff S is a subspace of V.
(8)
3. (a) Prove that any subset of a linearly independent set is linearly independent. **(8)**
(b) Prove that any set containing a linearly dependent set is also linearly dependent. **(8)**

4.(a)Let S={v_1 ,v_2 , v_3............v_n}be a linearly uniquely independent set of vectors in a vector space V over a field F.Then every element of L(S) can be written in the form V = S+W. **(8)**

(b) $S=\{v_1 ,v_2,..........v_n\}$ is a linearly dependent set of vectors in V iff there exists a vector $v_k \in S$ such that v_k is a linear combination of the precediang vectors v_1 ,v_2,..............v_{k-1}.**(8)**

5. (a)Let V be a vector space over F .Let $S=\{v_1 ,v_2,..........v_n\}$ and L(S)=W.Then there exists a linearly independent subset S' of S such that L(S')=W. **(8)**

(b)A non empty subset W of V_F is a subspace iffα+cβ∈W, for any α,β∈W and c∈F. **(8)**

6. (a)Any two bases of finite dimensional vector space V have the same number of elements. **(8)**

(b) Let V be a vector space of dimension n .Then (i) any set of m vectors m>n is linearly dependent. (ii) any set of m vectors where m,n cannot span V. **(8)**

7. (a)Let V be a finite dimensional vector space over a field F.Any linearly independent set of in V is part of basis. **(8)**

(b)Let V be a finite dimensional vector space over a field F.Let A be a subspace of V .Then there exists a subspace B of V such that $V = A \oplus B$. **(8)**

8. (a)Let V be a vector space over a field F.Let $S=\{v_1 ,v_2,..........v_n\} \subseteq V$ .Then the following are Equivalent.(i) S is a basis of V.(ii) S is a maximal linearly independent set. (iii) S is a minimal generating set. **(8)**

(b) Any vector space of dimension n over a field F is isomorphic to V_n(F). **(8)**

9. (a)Obtain the matrix representing the linear transformation $T : V_3(R) \to V_3(R)$ given by T(a,b,c)=(3a,a-b,2a+b+c) w.r.t the standard basis {e_1,e_2,e_3}. **(8)**

(b) Find the linear transformation determined by the matrix $\begin{pmatrix} 1 & -2 & 1 \\ 0 & 1 & 1 \\ -1 & 3 & 4 \end{pmatrix}$ w.r.t he standard basis {e_1,e_2,e_3}. **(8)**

10. (a)Let A be mxn matrix over a field F.Then rank(A)=k iff A is equivalent to the matrix $\begin{pmatrix} I_k & 0 \\ 0 & 0 \end{pmatrix}_{m\times n}$. **(8)**

(b)Two mxn matrices A and B over F are equivalent iff rank(A)=rank(B). **(8)**

11.(a) Let A=$\begin{pmatrix} 1_l & 1 \\ 0 & 0 \end{pmatrix}$then prove that A^2=A **(8)**

(b) Let A=$\begin{pmatrix} 1 & 1 & -2 & 0 & 0 \\ 1 & 2 & 3 & 6 & 7 \\ 2 & 1 & 3 & 6 & 5 \end{pmatrix}$ find rank (A). **(8)**

12. (a)If Qis an nxn matrix then the following are equivalent (i) Q is orthogonal (ii) $\|QX\| = \|X\|$ *for all xin* R^n (c)Qx*Qy=x*y for all x and y in R^n. **(8)**

(b)Using a co factor expansion compute the determinant of $A = \begin{bmatrix} 5 & -2 & 2 & 7 \\ 1 & 0 & 0 & 3 \\ -3 & 1 & 5 & 0 \\ 3 & -1 & -9 & 4 \end{bmatrix}$ **(8)**

13.(a)If a is an nxn matrix then (a) The only solution to the system Ax=0 is the trivial solution iff det(A)≠0.(b) The system Ax=0 willave a non trivial solution iffdet(A=0). **(8)**

(b) Find the eigen values and eigen vectors of $A=\begin{bmatrix}6 & 3 & -8\\ 0 & -2 & 0\\ 1 & 0 & -3\end{bmatrix}$ **(8)**

14.(a)Find the eigen values and eigen vectors of the following matrix $A=\begin{bmatrix}6 & 0 & 0 & 0 & 0\\ 9 & -4 & 0 & 0 & 0\\ -2 & 0 & 11 & 0 & 0\\ 1 & -1 & 3 & 0 & 0\\ 0 & 1 & -7 & 4 & 8\end{bmatrix}$ **(8)**

b.Find a matrix P diagonalize $A=\begin{bmatrix}4 & 0 & 1\\ -1 & -6 & -2\\ 5 & 0 & 0\end{bmatrix}$ **(8)**

15.(a)Diagonalize $A=\begin{bmatrix}0 & 1 & 1\\ 1 & 0 & 1\\ 1 & 1 & 0\end{bmatrix}$ **(8)**

(b)Neither the following matrices are diagonalizable(i) $A=\begin{bmatrix}6 & 3 & -8\\ 0 & -2 & 0\\ 1 & 0 & -3\end{bmatrix}$

(ii) $A=\begin{bmatrix}4 & 0 & -1\\ 0 & 3 & 0\\ 1 & 0 & 2\end{bmatrix}$ **(8)**

UNIT III
INNER PRODUCT SPACES
PART – A

1. Define inner product space.

Let V be a vector space over F .An inner product on V is a function which assigns to each ordered pair of vectors u,v in V a scalar in F denoted by $\langle u,v\rangle$ satisfying the following conditions.

$(i)\langle u+v,w\rangle=\langle u,w\rangle+\langle v,w\rangle$

$(ii)\ \langle \alpha u\ ,v\rangle=\alpha\langle u,v\rangle$

$(iii)\ \langle u,v\rangle=\langle \overline{v,u}\rangle$

where $\langle \overline{v,u}\rangle$ is the complex conjugate of $\langle u,v\rangle$

(iv) $\langle u,u\rangle\geq 0$ *and* $\langle u,u\rangle$ =0 iff u=0 .

A vector space with an inner product defined on it is called an inner product space.

2.Define distance between u and v.

If V is an inner product space and that u and v are two vectors in V .The distance between u and

v, denotred by d(u,v) is defined to be $d(u,v)=\|u-v\|$.

3.State the triangle inequlity.

Suppose u and v are two vectors in an inner product space and that c is a scalar then

(a) $\|u\| \geq 0$ (b) $\|u\| = 0$ iff $u = 0$ (c) $\|cu\| = |c|\|u\|$ (d) $\|u+v\| \leq \|u\| + \|v\|$

4. Define Euclidean space.

An inner product space is called an Euclidean space or unitary space according as F is the field of real numbers or complex numbers.

5. Define norm.

Let V be an inner product space and let $x \in V$.The norm or length of x,denoted by $\|x\|$, is defined

by $\|x\| = \sqrt{\langle x, x \rangle}$

6. Define orthogonal set.

Let V be an inner product space and let $x, y \in V$.X is said to be orthogonal to y if $\langle x, y \rangle = 0$.

7. Define orthonormal set.

S is said to be an orthonormal set if S orthogonal and $\|x\| = 1$ for all $x \in S$

8.Let S={v_1,v_2,..........v_n} be an orthogonal set of non zero vectors in an inner product space V.

Then prove that S is linearly independent.

Proof:

Let $\alpha_1 v_1 + \alpha_1 v_2 + \ldots\ldots\ldots\ldots\ldots \alpha_n v_n = 0$

Then $\langle \alpha_1 v_1 + \alpha_1 v_2 + \ldots\ldots\ldots\ldots\ldots \alpha_1 v_n, v_1 \rangle = \langle 0, v_1 \rangle = 0$

$\therefore \alpha_1 \langle v_1, v_1 \rangle + \alpha_2 \langle v_2, v_1 \rangle + \ldots\ldots\ldots + \alpha_n \langle v_n, v_1 \rangle = 0$

$\therefore \alpha_1 \langle v_1, v_1 \rangle = 0$(since S is orthogonal)

$\therefore \alpha_1 = 0$(Since $v_1 \neq 0$

Similarly $\alpha_2 = \alpha_3 = \ldots. = \alpha_n = 0$

Hence S is linearly independent.

9. Let S={v_1,v_2,..........v_n} be an orthogonal set of non zero vectors in V.Let v∈V and V=$\alpha_1 v_1 + \alpha_1 v_2 + \ldots\ldots\ldots\ldots\ldots \alpha_n v_n$.Then prove that $\alpha_k = \langle v, v_k \rangle / \| v_k \|^2$.

Proof:

$\langle v, v_k \rangle = \langle \alpha_1 v_1 + \alpha_1 v_2 + \ldots\ldots\ldots\ldots\ldots \alpha_n v_n, v_k \rangle$

$= \alpha_1 \langle v_1, v_k \rangle + \alpha_2 \langle v_2, v_k \rangle + \ldots\ldots\ldots + \alpha_n \langle v_n, v_k \rangle = \alpha_k \langle v_k, v_k \rangle$(since S is orthogonal)

$= \alpha_k \| v_k \|^2$

$\therefore \alpha_k = \langle v, v_k \rangle / \| v_k \|^2$

10.State the Cauchy's inequality.

For any α,β in an inner product space $V_F$$|(\alpha/\beta)| \leq \| \alpha \| \| \beta \|$

11. Define inner product space in linear algebra.

In linear algebra, an inner product space is a vector space with an additional structure called an

inner product. This additional structure associates each pair of vectors in the space with a scalar quantity known as the inner product of the vectors.

12. What is Gram schmidth ortoganalization Procedure.

Gram-Schmidt orthogonalization, also called the Gram-Schmidt process, is a procedure which

takes a nonorthogonal set of linearly independent functions and constructs an orthogonal basis

over an arbitrary interval with respect to an arbitrary weighting function .

13. What is the complement of a subspace?

In the mathematical fields of linear algebra and functional analysis, the orthogonal complement of a subspace W of a vector space V equipped with a bilinear form B is the set $W^{\perp}$ of all vectors in V that are orthogonal to every vector in W. Informally, it is called the perpendicular complement.

14. What is meant by orthogonal basis?

An orthogonal basis for an inner product space V is a basis for V whose vectors are mutually
orthogonal. If the vectors of an orthogonal basis are normalized, the resulting basis is an orthonormal basis.

15. What is the difference between orthogonal and orthonormal?

Two vectors are orthogonal if they are perpendicular to each other. i.e. the dot product of the
two vectors is zero. A set of vectors S is orthonormal if every vector in S has magnitude 1 and
the set of vectors are mutually orthogonal.

16. Define orthonormal subset.

A subset S of an inner product space V_F is called an orthonormal subset if for any $\alpha,\beta \in S$, $\|\alpha\|=1$, for $\alpha \neq \beta$, $\left(\frac{\alpha}{\beta}\right)=0$ if in addition ,S is a basis of V_F,it is called an orthonormal basis of V_F.

17.If S is any subset of V then prove that $S^{\perp}$ is a subspace of V.

Proof:

Clearly $0 \in S^{\perp}$ and hence $S^{\perp} \neq \emptyset$

Now let x,y $\in S^{\perp}$ and $\alpha , \beta \in F$

Then $\langle x,u\rangle=\langle y,u\rangle=0$ for all u $\in S$

$\therefore \langle \alpha x+\beta y,u\rangle=\alpha\langle x,u\rangle+\beta\langle y,u\rangle=0$ for all $u \in S$

$\alpha x+\beta y \in S^{\perp}$.Hence $S^{\perp}$ is a subspace of V.

18.Define inner product space isomorphism

Let V and V^* be two inner product spaces over the same field F. Then V is said to be isomorphic
to V^* if there exists a vector space isomorphism T of V onto V^* such that for any $\alpha,\beta \in V$
$(\alpha/\beta)=(T\alpha/T\beta)$ such an isomorphism T is called an inner product space isomorphism

19. Define adjoint of T.

Let T be a linear operator on an inner product space V_F.Then , alinear operator T^* on V is called the adjoint of T if $\left({T\alpha}/{\beta}\right)=\left({\alpha}/{T^*\beta}\right)$.

20. Define self adjoint operator.

A linear operator T on an inner product space V_F is said to be self adjoint if $\left({T\alpha}/{\beta}\right)=\left({\alpha}/{T\beta}\right)$
for all $\alpha,\beta \in V_F$

21. Define unitary matrix.

An nxn matrix A over C is called a unitary matrix iff $AA^*=A^*A=I_n$.

22.Define unitary operator.

Any linear operator T on a finite dimensional inner product space V is called a unitary operator

TT*=I=T*T.

23.Define orthogonal complement

Let S be a subset of R^n. The orthogonal complement of S denoted by $S^{\perp}$ is the set of all vectors

$x \in R^n$ that are orthogonal to S.

24.Define conjugate transpose.

For any mxn complete matrix A=[a_{ij}],its conjugate transpose A^* is the nxm matrix [a_{ij}'] such that

$a_{ij}'=\overline{a_{ji}}$

25.Define least square.

Given an inconsistent system ofvequations ,Ax=b we want to find a vector ,

$\bar{x}$ *from* R^m *so that the error* $\|\bar{\varepsilon}\| = \|b - A\bar{x}\|$ is the smallest possible error.The vector $\bar{x}$ is called the least squares solution.

PART-B

1. (a) Show that $V_2(R)$ is an inner product space with inner product defined by
$\langle x, y\rangle = x_1y_1 + x_2y_1 - x_1y_2 + 4x_2y_2$ Where x=(x_1,x_2) and y=(y_1,y_2). **(8)**

(b) Let V be the vector space of polynomials with inner product given by $\langle f, g\rangle = \int_0^1 f(t)g(t)dt$. Let

f(t)=t+2 and g(t)=t^2-2t-3 Find $\langle f, g\rangle$ *and* $\|f\|$. **(8)**

2. (a)Let S be subset of an inner product space V_F and W be the subspace spanned by S.Then $S^{\perp} = W^{\perp}$. **(8)**

(b)Let V_F be a finite dimensional inner product space,let L(V) be the lattice of all the subspaces of V. **(8)**

3. (a)) Using Gram-Schmidt orthogonalization process construct an orthogonal set from the given set S = {(1,0,1), (0,1,1), (1,3,3)} of R 3 . Also find the Fourier coefficient of the vector (1,1,2) with respect to the resultant orthogonal vectors. **(8)**

(b) Let T:P_2(R)→P_3 (R) be defined by T(f(x))= $2f'(x) + \int_0^x 3f(t)dt$. Jo Find bases for N(T) and R(T) and hence verify the dimension theorem. Is T one-to-one? Is T onto? Justify your answer.**(8)**

4. (a)Let V and W be vector spaces and let T : V —> W be a linear transformation. If V is finite-dimensional then prove that nullity (T) + rank(T) = dimension(V) . **(8)**

(b) For the linear operator T : P2 (R) -»• P 2 (R) defined as T(f(x)) = f(x) + xf'(x) + f"(x), find the eigenvalues of T and an ordered basis B for P2 (M) such that the matrix of the given transformation with respect to the new resultant basis B is a diagonal matrix. **(8)**

5. (a) Let V_F be a finite dimensional inner product space T be a linear operation on V .Then ,there

exists a unique linear operator T^* on V such that $\left(T\alpha / \beta\right)=\left(\alpha / T^*\beta\right)$ **(8)**

(b)Using Least square approximation determine the best linear fit for the data: {(1,2), (2,3), (3,5), (4,7)}. **(8)**

6. (a) Solve the system of differential equations using diagonalization and discuss its stability: x'(t) =5x(t) + 4y(t) y'{t) = x(t) + 2y(t). **(8)**

(b) Let V be an inner product space over R. For all $\bar{x}, \bar{y} \in V$ prove the following:

(i) Cauchy-Schwarz inequality $\left\|\left\langle \bar{x}\ , \bar{y}\right\rangle\right\| < \left\|\bar{x}\right\| \left\|\bar{y}\right\|$ and (ii) Triangle inequality $\left|\bar{x}+\bar{y}\right| \le \left|\bar{x}\right| + \left|\bar{y}\right|$ **(8)**

7. (a)Let V= C^4 .Now $\alpha_1=(1,1,1,0), \alpha_2=(0,1,1,1), \alpha_3=(0,0,1,1)$ $\alpha_4=(0,0,3,0)$ form a basis of V. **(8)**

(b) Find an orthonormal basis of the subspace W of the complex inner product space C^4,spanned by X_1=(3,-i,0,0) , X_2=(2,2i,1,0).Find an orthogonal basis of C^4 that contains this orthonormal basis of W.**(8)**

8.(a) Let B an orthonormal basis of an inner product space V_F.If $B = B_1 \cup B_2$ *such that* $B_1 \cap B_2 = \phi$,prove that for the subspace W of V generated by B_1, $W^\perp$ is the subspace generated by B_2.**(8)**

(b) Given a finite dimensional real vector space V and any basis B of V,define an inner product in V such that B becomes an orthogonal basis of V. **(8)**

9. (a) Find an inner product on R^2 such that for $\alpha_1=(1,3), \alpha_2=(4,1), B=\{\alpha_1,\alpha_2\}$becomes an orthonormal basis. **(8)**

(b) State and prove the spectral theorem.**(8)**

10. (a) If a self adjoint linear operator is nilpotent , prove that it is zero. **(8)**

(b) Apply Gram Schmidt process to construct an orthonormal basis for V_3(R) with the Standard inner product for the basis {v_1,v_2,v_3} where v_1=(1,0,1),v_2=(1,3,1) and v_3=(3,2,1).**(8)**

11. (a)Find a vector of unit length which is orthogonal to (1,3,4) in V_3(R) with the standard inner product.**(8)**

(b) Let T be a linear operator on a finite dimensional complex inner product space V.Then $T=T_1+iT_2$ for some uniquely determined self adjoint linear operatora T_1, T_2 on V. **(8)**

12. (a) Let T be linear operator on a finite dimensional inner product space .Then the following are equivalent:

(i) T is an inner product space automorphism

(ii) $TT^* = T^*T = I$ (iii) $\|T\alpha\| = \|\alpha\|$ for every $\alpha \in V$ **(8)**

(b)A vector $\hat{X}$ is a least squares solutions of the system Ax=b if and only if it is a solution of the associated normal system $A^TAx=A^Tb$. **(8)**

13. (a) Find the least squares solution to $\begin{cases} x+2y=3 \\ 3x+3y=5 \\ x+y=2.09 \end{cases}$ **(8)**

(b)Find the least squares solution to $\begin{cases} 2x+y=10 \\ 3x+3y=6 \\ x+y=6.05 \end{cases}$ **(8)**

14.(a) The normal system $A^I Ax = A^I b$ is always consistent.Also the following conditions are equivalent:

(i) the least squares problem has a unique solution,
(ii) the system Ax=0 has only zero solution,
(iii) columns of A are linearly independent. **(8)**

(b) Find the linear polynomials that is the least square fit to the following data **(8)**

X	0	1	2	3
f(X)	1	0	1	2

15. (a)Use least squares to find the equation of the line that will best approximation the points
(- 3,70),(1,21),(-7,110) and (5,-35).**(8)**

(b)Find the least squares solution to the following system of equations

$$\begin{bmatrix} 2 & -1 & 1 \\ 1 & -5 & 2 \\ -3 & 1 & -4 \\ 1 & -1 & 1 \end{bmatrix}\begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} = \begin{bmatrix} -4 \\ 2 \\ 5 \\ -1 \end{bmatrix}$$ **(8)**

UNIT-IV
PARTIAL DIFFERENTIAL EQUATIONS
PART A

1. Form a PDE by eliminating the arbitrary constants 'a' and 'b' from z = ax^2+by^2.
(AU-A/M- 2017)

Given z = ax^2+by^2

p = 2ax $\Rightarrow \frac{p}{2}$ = ax---------------------------- (1), q = 2by$\Rightarrow \frac{q}{2}$ = by------------------------------ (2)

From (1) and (2) ,eliminate a and b

z = $\frac{px}{2}+\frac{qy}{2}$

2z = px+qy

2. Form the partial differential equation from $(x-a)^2+(y-b)^2+z^2 = 1$,by eliminating a and b.

Partial differentiation w.r.to x and y gives **(AU-M/J-2013)-2**

2(x-a)+2zp=0 ; (x-a)= - pz
2(y-b)+2zq=0 ; (y-b)= - qz
Using these in the given equation we get ,
$p^2z^2+q^2z^2+z^2=1$

3. Form the p.d.e from $z=ax^3+by^3$(AU-M/J-2014)-2

$z=ax^3+by^3$ ....(1)

$\frac{\partial z}{\partial x} = 3ax^2$; $\frac{\partial z}{\partial y} = 3ay^2$ ie) p= $3ax^2$ q= $3ay^2$

ie) $\frac{p}{3x^2} = a$ $\frac{q}{3y^2} = b$ (1)$\Rightarrow$z= $\frac{px}{3}+\frac{qy}{b}$ ie) 3z=px+qy

4. Form a PDE by eliminating the arbitrary function f from $z = e^{ay}f(x+by)$ (AU-A/M-2017)

$$z = e^{ay} f(x+by)$$

$$p = \frac{\partial z}{\partial x} = e^{ay} f'(x+by).1$$

$$q = \frac{\partial z}{\partial y} = e^{ay} f'(x+by).b + f(x+by)e^{ay}.a = e^{ay}\frac{p}{e^{ay}}b + f(x+by)e^{ay}.a$$

$$q = pb + f(x+by)e^{ay}.a.$$

$$\frac{q-pb}{ae^{ay}} = f(x+by) = \frac{z}{e^{ay}}$$

$q - pb = a$ is the required PDE

5. Find the PDE of all spheres whose centre lie on x=y=z. (AU-N/D-2016)-3

General equation of the sphere is

$(x-a)^2 + (y-b)^2 + (z-c)^2 = r^2$

Here centre is (a,b,c) and radius r. Centre lies on x =y = z . i.e a = b = c.

Equation of the sphere is $(x-a)^2 + (y-b)^2 + (z-c)^2 = r^2$ --------------(1)

Diff. w.r.to x partially 2(x-a) +2(z-a) $\frac{\partial z}{\partial x}$ = 0 ; (x-a) + (z-a) p= 0 ----(2)

Diff. w.r.to y partially 2(y-a) +2(z-a) $\frac{\partial z}{\partial y}$ = 0 ; (y-a) + (z-a) q= 0 ----(3)

(2) $\Rightarrow$ x – a+zp –ap = 0 ; x + zp = a+ap ; x+zp = a(1+p) ------------- (4)

(3) y –a+ zq - aq = 0 ; y + zq = a + aq; y + zq = a(1+q) ------------(5)

(4) / (5) x+xq+zp+zpq = y+yp+zq+zpq

x+xq+zp-y-yp-zq = 0 ; x-y+(x-z)q+(z-y)p = 0

x-y = (z-x)q+(y-z)p ; (z-x)q+(y-z)p = x-y.

6. Form the partial differential equation by eliminating the arbitrary constants a and b from

log(az-1) = x+ay+b (AU-A/M-2015)

Given log(az-1) = x+ay+b -------------------------------(1)

Differentiating w.r.t x : $\frac{1}{az-1}ap = 1$ --------------------(2)

Differentiating w.r.t y : $\frac{1}{az-1}aq = a$ ---------------------(3)

From (2) : $a = \frac{1}{z-p}$ --------------------------------------(4)

From (3) : q= az-1 ---(5)

Solving (4) and (5) and eliminate 'a'.

p(q+1) = zq

This is the required PDE.

7. Form the p.d.e by eliminating the arbitrary function f from z = f(y/x).(AU- N/D-2012)-2

Given: $z = f\left(\frac{y}{x}\right)$. -------------- (1)

Diff. (1) p.w.r.to x we get $\frac{\partial z}{\partial x} = p = f'\left(\frac{y}{x}\right)\left(\frac{-y}{x^2}\right)$ -------- (2)

Diff. (1) p.w.r.to x we get $\frac{\partial z}{\partial y} = q = f'\left(\frac{y}{x}\right)\left(\frac{1}{x}\right)$ -------- (3)

$\frac{p}{q} = \left(\frac{-y}{x^2}\right)\left(\frac{1}{x}\right) = \left(\frac{-y}{x}\right)$; xp + yq = 0 is the required p.d.e.

8. Form the p.d.e by eliminating the function f from $z = f(x^2-y^2)$ (AU-N/D-2017)

Given $z = f(x^2-y^2)$

Differentiation w.r.to x : $p = f'(x^2-y^2).2x$----------------(1)

Differentiation w.r.to y : $q = f'(x^2-y^2).-2y$ ----------------(2)

Eliminating f from (1) and (2)

$\frac{(1)}{(2)} \Rightarrow \frac{p}{q} = \frac{-x}{y}$,

Px – qy = 0. This is the required p.d.e.

9. Form the p.d.e by eliminating the arbitrary function $f(x^2-y^2, z) = 0$. (AU -N/D-2014)

Given $x^2-y^2 = f(z)$

Partially differentiating w.r.to x , 2x = f′(z)p------(1)

Partially differentiating w.r.to y , -2y = f′(z)q------(2)

(1)/(2)implies that p/q = -x/y

py = -qx , qx+py = 0.This is the required p.d.e.

10. Form the p.d.e by eliminating the arbitrary function from $f(x^2+y^2, z-xy) = 0$. (AU-M/J-2016)

Given $x^2+y^2 = f(z-xy)$

Partially differentiating w.r.to x, 2x = f′(z-xy)(p-y)-------(1)

Partially differentiating w.r.to y, 2y = f′(z-xy)(q-x)-------(2)

(1)/(2)implies that x/y = (p-y)/(q-x)

$qx-x^2 = py-y^2$ This implies that $x^2+y^2 = qx- py$. This is the required p.d.e.

11.Find the complete integral of p+q = 1.(AU- N/D- 2014)

Given p+q = 1--------------------------(1)

Let z = ax+by+c-----------------------(2)

$\frac{\partial z}{\partial x} = p = a$ and $\frac{\partial z}{\partial y} = q = b$ -----(3)

Substitute equation (3) in equation (1) , we get a+b = 1

That is b = 1- a--------------------(4)

Substitute equation (4) in equation (2),we get Z = ax + (1-a) y+ c is the complete integral.

12. Find the complete solution of the partial differential equation $p^3-q^3 = 0$. AU-A/M-2016)

This equation is of the form F(p,q) = 0

Hence the trial solution is z = ax+by+c

p= a and q = b

Therefore $a^3 – b^3 = 0$

13. Find the complete integral of $\sqrt{p} + \sqrt{q} = 1$ (AU-N/D-2017)

$\sqrt{p}+\sqrt{q}=1$--- (1)

This is of the type F(p,q)=0

The trial solution is z=ax+by+c

Sub. p=a and q=b in (1)

Therefore (1) implies $b=\left(1-\sqrt{a}\right)^2$

Then, $z=ax+\left(1-\sqrt{a}\right)^2 y+c$ which is Complete Integral

14. Find the complete integral of $\frac{z}{pq}=\frac{x}{q}+\frac{y}{p}+\sqrt{pq}$ **(AU-N/D-2016)**

This is of the form z = px + qy + f(p,q)

Given $z = px+qy+(pq)^{3/2}$

Hence the complete integral is $z = ax+by+(ab)^{3/2}$

15. Find the complete integral of p+q=x+y **(AU-N/D-2013)-2**

Let p+q=x+y=k

p-x=k, y-q=k

p=k+x, q=y-k

$= kx+\frac{x^2}{2}+\frac{y^2}{2}-ky+c$

16. Find the complete solution of q = 2px. **(AU-A/M-2015)**

q=2px=a (say)

q=a; p=a/2x

dz = (a/2x) dx + ady

Integrating,

Z = (a/2) logx + ay +b

This is the complete solution.

17.Find the general solution of the Lagrange linear equation given by pyz+qzx = xy. (AU-N/D-2013)

This is of the form : Pp+Qq= R

Auxiliary equation is : $\frac{dx}{P}=\frac{dy}{Q}=\frac{dz}{R} \Rightarrow \frac{dx}{yz}=\frac{dy}{zx}=\frac{dz}{xy}$

Group 1: $\frac{dx}{yz}=\frac{dy}{zx}$

xdx = ydy

Integrating , $x^2/2 = y^2/2+c_1^2/2$

$x^2-y^2 = u$

Group 2: $\frac{dx}{yz}=\frac{dz}{xy}$

xdx = zdz

Integrating, $x^2-z^2 = v$

Therefore the solution is φ(u,v) = 0

$\Phi(x^2-y^2, x^2-z^2) = 0$

18. What is the C.F of $(D^2-DD')z=x+y$

The A.E is $m^2-m=0$ implies m=2(twice)

Therefore C.F = $f_1(y+2x)+xf_2(y+2x)$

19. Solve $(D^4-D'^4)z = 0$. **(AU- M/J -2014)**

A.E is $m^4-1^4 = 0$

$(m^2)^2-(1^2)^2 = 0$ implies that $(m^2+1)(m^2-1) = 0$

m= 1,-1 and m = i,-i

$z = f_1(y+x)+f_2(y-x)+f_3(y+ix)+f_4(y-ix)$.

20. Solve $(D^3-3DD'^2+2D'^3)z = 0$.(AU A/M 2018)-3

A.E is $m^3-3m+2 = 0$

m= 1,1,-2

The solution is $z = f_1(y-2x)+f_2(y+x)+xf_3(y+x)$

21. Solve $(D^3-D^2D'-8DD'^2+12D'^3)z=0$

The A.E is $m^3-m^2-8m+12=0$

m=2,2,-3

The Solution is , z= $f_1(y+2x)+xf_2(y+2x)-f_3(y-3x)$

22. Find the particular integral of $(D^2-D'^2+DD')z = \cos(x+y)$.(AU-N/D- 2012)

P.I = $\frac{1}{(D^2+DD'-D'^2)}\cos(x+y)$ [Replace D^2,DD',D'^2 by -1,-1,-1]

$$=\frac{1}{0}\cos(x+y)=\frac{1}{2D+D'}\cos(x+y)=\frac{2D-D'}{4D^2-D'^2}\cos(x+y)=\frac{2D-D'}{-3}\cos(x+y)$$

$$=\frac{-2\sin x+\sin y}{-3}$$

23. Solve $\frac{\partial^2 z}{\partial x^2}-\frac{\partial^2 z}{\partial x\partial y}+\frac{\partial z}{\partial x}$ = 0 (AU-N/D- 2013)

$(D^2-DD'+D)=0$

$D(D-D'+1) = 0$ that implies $(D-m_1D'-0)(D-D'+1) = 0$

$m_1 = 0$, $c_1 = 0$, $m_2 = 1$,$c_2 = -1$

The solution is $z = e^{0x}f_1(y)+e^{-x}f_2(y+x)$

24. Solve $\frac{\partial^2 z}{\partial x\partial y}=0$ **(AU-A/M-2017)**

$$\frac{\partial^2 z}{\partial x\partial y}=\frac{\partial}{\partial x}\left(\frac{\partial z}{\partial y}\right)=0\Rightarrow\partial\left(\frac{\partial z}{\partial y}\right)=0$$

$$\int\partial\left(\frac{\partial z}{\partial y}\right)=0,\quad\left(\frac{\partial z}{\partial y}\right)=f(y)\Rightarrow\partial z=f(y)\partial y\Rightarrow\int\partial z=\int f(y)\partial y$$

z=F(y)+g(x)

25. Solve $(D+D'-1)(D-2D'+3)z = 0$ **(AU-N/D-2015)**

Here $c_1 = 1$ $c_2 = -3$ $m_1= -1$ $m_2 = 2$

C.F = $e^xf_1(y-x)+e^{-3x}f_2(y+2x)$

PART – B

1. (a) Form the PDE by eliminating the arbitrary function φ from the relation $\Phi(x^2+y^2+z^2, xyz) = 0$. **(AU-M/J-2016)-2-(8)**

(b) Find the partial differential equations of all planes which are at a constant distance 'k' units from the origin. **(AU-A/M-2016)(8)**

2. (a) Form the PDE by eliminating the arbitrary function 'f' and 'g' from $z = x^2f(y) + y^2g(x)$ **(AU-N/D-2013)(8)**

(b) Form the PDE by eliminating the arbitrary functions 'f' and 'ϕ' from the relation $z = x f(y/x) + y\,\phi(x)$.**(AU-A/M-2016)(8)**

3. (a) Form the partial differential equation by eliminating arbitrary functions from $z = y^2+2f(1/x+\log y)$**(AU-M/J-2014)(8)**

(b)Find the complete solution of $9(p^2z + q^2) = 4$.**(AU-N/D-2014)-2(8)**

4. (a) Find the singular solution of the p.d.e. $z = px+qy+\sqrt{1+p^2+q^2}$ **(AU-N/D-2015)-4(8)**

(b) Solve: $z = px + qy + p^2+p-q^2$. **(AU-M/J-2014)-2(8)**

5. (a) Find the general solution of $z=px+qy+p^2+pq+q^2$ **(AU A/M 2018)-3(8)**

(b) Find the singular solution of $z = px+qy+p^2-q^2$**(AU A/M 2017)-4 (8)**

6. (a) Solve $p^2x^2+q^2y^2 = z^2$. **(AU-N/D-2014)-2-(8)**

(b) Solve $z = px+qy+p^2q^2$ and obtain its singular solution.**(AU-A/M-2015)- (8)**

7. (a) Find the complete solution of $z^2 (p^2+q^2) = x^2 + y^2$. **(AU-A/M-2015)- (8)**

(b) Obtain the complete solution of $p^2+x^2y^2q^2 = x^2z^2$**(AU –M/J-2015)-(8)**

8. (a)Find the general solution of $(z^2-2yz-y^2)p+(xy+zx)q=xy-zx$**(AU A/M 2017)(8)**

(b) Find the general solution of $(z^2-y^2-2yz)\,p+(xy+zx)q = (xy-zx)$**(AU-A/M-2015)- (8)**

9. (a)Solve $(x^2-yz)p + (y^2-zx)q = (z^2-xy)$ **(AU-A/M-2016)-3(8)**

(b) Solve $(x-2z)p + (2z - y)q = y-x$ **(AU-A/M-2017)(8)**

10. (a)Solve $x(y-z)p+y(z-x)q = z(x-y)$**(AU-M/J-2014)-2(8)**

(b)Solve $x(z^2-y^2)p + y(x^2-z^2)q = z(y^2-x^2)$ **(AU-M/J-2016)-3(8)**

11. (a) Solve $(D^3-2D^2D')z = 2e^{2x}+3x^2y$.**(AU-A/M-2016)(8)**

(b) Solve $(D^2-5DD'+6D'^2)z = y\sin x$ **(AU N/D 2017)(8)**

12. (a) Solve $(D^2+DD'-6D'^2)z = y\cos x$ (OR) $(r+s-6t)=y\cos x$. **(AU-A/M-2018)-3(8)**

(b)Find the general solution of $(D^2+2DD'+D'^2)z=xy+e^{x-y}$**(AU N/D 2017)(8)**

13. (a) Solve $(D^3-7DD'^2-6D'^3)z = \sin(2x+y)$ **(AU-M/J- 2013)(8)**

(b)Find the general solution of $(D^2+2DD'+D'^2)z=x^2y+e^{x-y}$**(AU-A/M-2017)(8)**

14. (a)Solve: $(D^2-3DD'+2D'^2)z = (2+4x)e^{x+2y}$ **(AU-N/D-2015)-2(8)**

(b).Find the general solution of $(D^2-3DD'+2D'^2+2D-2D')z=\sin(2x+y)$ **(AU A/M 2017)(8)**

15. (a) Solve $(D^2+2DD'+D'^2-2D-2D')z = \sin(x+2y)$**(AU-N/D-2015)(8)**

(b)Solve : $(D^2+4DD'-5D'^2)z=\sin(x-2y)+e^{2x-y}$ **(AU-N/D-2017)(8)**

UNIT - V

FOURIER SERIES SOLUTIONS OF PARTIAL DIFFERENTIAL EQUATIONS

PART A

1. State Dirichlet's conditions for a given function to expand in Fourier series.
(AU -N/D- 2017)-8

Let f(x) be defined in the interval $c<x<c+2\pi$ with period 2π and satisfy the following conditions:

(1) f(x) is single valued

(2) It has a finite number of discontinuities in a period of 2π.

(3) It has a finite number of maxima and minima in a given period.

(4) $\int_{c}^{c+2\pi} |f(x)|dx$ is convergent

These conditions are Dirichlet's conditions.

2. State the sufficient conditions for existence of Fourier series.(AU A/M 2017)-2

The sufficient conditions for existence of Fourier series is given by

(i) f(x) is defined and single valued except possibly at a finite number of points in (-π, π).

(ii) f(x) is periodic with period 2π.

(iii) f(x) and f ′(x) are piecewise continuous in (-π, π), then the Fourier series of f(x) converges to

(a) f(x) if x is a point of continuity

(b) $\frac{f(x+0)+f(x-0)}{2}$ if x is a point of discontinuity.

3. If f(x) is discontinuous at a point x=a, then what does its Fourier series represent at that point (AU-N/D-2017)

If f(x) is discontinuous at a point x=a, then at that point f(x) cannot beexpanded as Fourier series.

4. Find the constant term in the Fourier series corresponding to f(x) = cos²x expressed in the interval (-π, π).(AU-M/J-2012)

Given f(x) = cos²x = $\frac{1+\cos 2x}{2}$

We know that f(x) = $\frac{a_0}{2}+\sum_{n=1}^{\infty} a_n \cos nx+\sum_{n=1}^{\infty} b_n \sin nx$

$$a_0 = \frac{1}{\pi}\int_{-\pi}^{\pi}\cos^2 x dx = \frac{2}{\pi}\int_{0}^{\pi}\cos^2 x dx = \frac{2}{\pi}\int_{0}^{\pi}\frac{1+\cos 2x}{2}dx = \frac{1}{\pi}\int_{0}^{\pi}(1+\cos 2x)dx = 1$$

Therefore the Constant term = $\frac{a_0}{2}=\frac{1}{2}$

5. Find a_0 in the expansion of f(x)=e^x as a Fourier series in ; 0<x<2π (AU-N/D-2013)

$$a_0 = \frac{1}{\pi}\int_{0}^{2\pi} f(x)dx = \frac{1}{\pi}\int_{0}^{2\pi} e^x dx = \frac{1}{\pi}\left[e^x\right]_0^{2\pi} = \frac{1}{\pi}\left[e^{2\pi}-1\right]$$

6.Determine the Fourier series for the function f(x) = x in $-\pi \le x \le \pi$. (AU-N/D-2015)

f(x) = x

f(-x) = -x = -f(x)

Therefore f(x) is an odd function .Therefore $a_0 = a_n = 0$

$$b_n = \frac{1}{\pi}\int_{-\pi}^{\pi} f(x)\sin nx dx = \frac{1}{\pi}\int_{-\pi}^{\pi} x\sin nx dx$$

u = x　　v = sin nx

u′ = 1　　v_1 = -cosnx/n

u″ = 0　　v_2 = -sinnx/n²

$$b_n = \frac{1}{\pi}\left[\frac{-x\cos nx}{n}+\frac{\sin nx}{n^2}\right]_{-\pi}^{\pi} = \frac{1}{\pi}\left[\frac{-2\pi(-1)^n}{n}\right] = \frac{-2(-1)^n}{n}$$

$$f(x) = \sum_{n=1}^{\infty} \frac{-2(-1)^n}{n} \sin nx$$

7.Find the value of b_n in the Fourier series expansion of f(x) = x+ π in (-π, 0) = -x + π in (0, π) (AU-M/J-2016)

Let f(x)= $\phi_1(x)$, (-π, 0)

= $\phi_2(x)$, (0, π)

$\phi_1(x) = x+\pi$, $\phi_2(x) = -x+\pi$

$\phi_1(-x) = -x+\pi = \phi_2(x)$

f(x) is an even function. Therefore $b_n=0$.

8. Find b_n in the expansion of f(x)=x^2 as a Fourier series in ; -π<x<π . (AU-N/D-2017)

$f(-x)=(-x)^2=x^2=f(x)$

Therefore f(x) is an even function. $\therefore b_n = 0$

9. Find the sum of the Fourier series for f(x) = x+x^2 in – π<x< π at x = π.(AU-A/M-2017)

x= π is an end point. Sum of Fourier series = $\frac{f(\pi)+f(-\pi)}{2}$ = $\frac{\pi+\pi^2-\pi+\pi^2}{2} = \frac{2\pi^2}{2} = \pi^2$

10. Expand f(x) = 1 as a half range sine series in the interval (0, π) (or)
Find the sine series of function f(x) = 1 , 0 ≤ x ≤ π (AU-A/M-2015)-3

The half range sine series formula is f(x) = $\sum_{n=1}^{\infty} b_n \sin nx$

Where $b_n = \frac{2}{\pi}\int_0^{\pi} f(x)\sin nx dx = \frac{2}{\pi}\int_0^{\pi} \sin nx dx = \frac{2}{\pi}\left[\frac{-\cos nx}{n}\right]_0^{\pi} = \frac{2}{\pi}\left[\frac{-(-1)^n}{n} \frac{1}{n}\right]$

$= \frac{2}{n\pi}\left[1-(-1)^n\right] = \frac{4}{n\pi}$ *if n is odd* , $f(x) = \sum_{n is odd} \frac{4}{n\pi} sin nx$

11.If $(\pi - x)^2 = \frac{\pi^2}{3} + 4\sum_{n=1}^{\infty} \frac{\cos nx}{n^2}$ in 0<x<2π, then deduce that the value of $\sum_{n=1}^{\infty} \frac{1}{n^2}$ (AU-N/D-2014)

Put x = 0, $\pi^2 - \frac{\pi^2}{3} = 4\sum_{n=1}^{\infty}\frac{1}{n^2} \Rightarrow \frac{2\pi^2}{12} = \sum_{n=1}^{\infty}\frac{1}{n^2} \Rightarrow \frac{\pi^2}{6} = \sum_{n=1}^{\infty}\frac{1}{n^2}$

12. Write down the form of the Fourier series of an odd function in (-l,l) and associated Euler's formulas for Fourier coefficients.(AU-N/D-2013)

f(x) = $\sum_{n=1}^{\infty} b_n \sin \frac{n\pi x}{l}$

$b_n = \frac{1}{l}\int_{-l}^{l} f(x)\sin\frac{n\pi x}{l} dx$

13.Classify the PDE of $u_{xy}=u_x u_y+xy$ (AU-N/D-2017)

Here B=1,A=0,C=0

B^2-4AC=1>0

$\therefore$ Given PDE is Hyperbolic equation.

14. Use method of separation of variables, Solve $\frac{\partial u}{\partial x} = 2\frac{\partial u}{\partial t} + u$**, where u(x,0)=6e^{-3x}**

(AU A/M 2017)

$$u = abe^{kx}e^{\frac{1}{2}(k-l)}$$
$$u(x,0) == abe^{kx}$$
$$u(x,0) = 6e^{-3x}$$
$$ab = 6, k = -3$$
$$\therefore u = 6e^{-(3x+2t)}$$

15. What is the basic difference between the solutions of one dimensional wave equation and one dimensional heat equation with respect to the time?(AU- N/D- 2017)-2

Solution of the one dimensional wave equation is of periodic in nature. But solution of the One dimensional heat equation is not of periodic in nature.

16. State the assumptions in deriving one-dimensional wave equation. (AU- N/D-2017)-3

(i) The motion takes place entirely in one place i.e., xy plane.
(ii) Only transverse vibrations are considered. The horizontal displacement of the particles of the string is negligible.
(iii) The tension T is constant at all times and at all points of the deflected string.

(iv) T is considered to be so large compared with the weight of the string and hence the force of gravity is negligible.
(v) The effect of friction is negligible.
(vi) The string is perfectly flexible,i.e., it can transmit tension but not bending or sheering forces.
(vii) The slope of the deflection curve at all points and at all instants is so small that sin α can bereplaced by α, where α is the inclination of the tangent to the deflection curve.

17. Write down one-dimensional heat equation and all possible solution for the same. (AU-A/M-2018)-10

$u_t=\alpha^2 u_{xx}$

$$u(x,t) = \left(A_1e^{\lambda x} + B_1e^{-\lambda x}\right)C_1e^{\alpha^2\lambda^2 t}$$
$$u(x,t) = \left(A_2\cos\lambda x + B_2\sin\lambda x\right)C_2e^{-\alpha^2\lambda^2 t}$$
$$u(x,t) = \left(A_3x + B_3\right)C_3.$$

18. State the suitable solution of the one dimensionalheat equation $\frac{\partial u}{\partial t} = a^2\frac{\partial^2 u}{\partial x^2}$ **(AU-A/M-2017)**

The suitable solution of the given equation is u(x,t) = (Acospx+Bsinpx) $e^{-c^2p^2t}$

19. State the governing equation for one dimensional heat equation and necessary conditions to solve the problem.

The one dimensional heat equation is $\frac{\partial u}{\partial t} = a^2 \frac{\partial^2 u}{\partial x^2}$ where u(x,t) is the temperature at time t at a point distant x from the left end of the rod. The boundary conditions are

a)$u(0,t) = k_1{}^0C$ for all $t\geq 0$

b)$u(l,t) = k_2{}^0C$ for all $t\geq 0$

c)$u(x,0) = f(x)$, $0<x<l$

20. A rod of 30cm long has its ends A and B kept at 20^0C and 80^0C respectively until steady state conditions prevail. Find the steady state temperature in the rod.(AU-A/M-2015)-2

The steady state equation of the one dimensional heat flow is $\frac{d^2u}{dx^2}$ =0 ....(1)

The general Solution of (1) is u(x) =ax+b ......(2)

The boundary conditions are u(0) = 30, and u(30)=80

Put x=0 in (2) , u(0)=b=20

Put x=30in (2) , u(30)=30a+b =80

30a+b=80 that implies 30a=60 implies that a=2 and equation (2) implies u(x)=2x+20

21. A rod of length 20cm whose one end is kept at 30^0C and the other end is kept at 70^0C is maintained so until steady state prevails. Find the steady state temperature. (AU-N/D-2014)-2

The steady state equation of one dimensional heat flow is $\frac{d^2u}{dx^2}$ =0 ......(1)

The general Solution of (1) is u(x) =ax+b ......(2)

The boundary conditions are u(0) = 30, and u(l)=70

Put x=0 in (2) , u(0)=b=30

Put x=l in (2) , u(l)=al+b =70

al=40 that implies a=40/l

(2) implies u(x)=$\frac{40}{l}x + 30$ Here l=20.Therefore u(x)=2x+30

22. An insulated rod of length *l* cm has its ends A and B maintained at 0^0C and 80^0C respectively. Find the steady state solution of the rod (AU-N/D-2013)

The steady state equation of the one dimensional heat flow is $\frac{d^2u}{dx^2}$ =0 ....(1)

The general Solution of (1) is u(x) =ax+b ......(2)

The boundary conditions are u(0) = 0, and u(l)=80

Put x=0 in (2) , u(0)=b=0

Put x=l in (2) , u(l)=la+b =80

la+b=80 that implies la=80 implies that a=80/l and equation (2) implies u(x)=(80/l)x

23. A bar of length 50cm has its ends kept at 20^0C and 100^0C until steady state conditions prevail. Find the temperature at any point of the bar. (AU-A/M-2014)

The steady state equation of one dimensional heat flow is $\frac{d^2u}{dx^2}$ =0 ....(1)

The general solution of (1) is u(x)=ax+b ....(2)

Put x=0 in (2) , u(0) = b = 20

Put x=l in (2), u(l) = al+b=100

al=80

a=80/l

a=80/50 that is a=8/5. Equation (2) implies u(x) = $\frac{8}{5}x+20$

24. A rod of 60cm long has its ends A and B kept at 20^0C and 80^0C respectively until steady
state conditions prevail. Find the steady state temperature in the rod.(AU-N/D-2012)

The steady state equation of the one dimensional heat flow is $\frac{d^2u}{dx^2}$ =0 ....(1)

The general Solution of (1) is u(x) =ax+b ......(2)
The boundary conditions are u(0) = 20, and u(60)=80

Put x=0 in (2) , u(0)=b=20
Put x=60in (2) , u(60)=20a+b =80
20a+20=80 that implies 20a=60 implies that a=3 and equation (2) implies u(x)=3x+20

25. Write all possible solutions of two dimensional heat equations $\frac{\partial^2 u}{\partial x^2}+\frac{\partial^2 u}{\partial y^2}=0$

(AU-N/D-2017)-6

$u(x,y)= (A_1e^{px}+ A_2e^{-px})(A_3 \cos py+A_4\sin py)$
$u(x,y)=(A_5\cos px+A_6\sin px)(A_7 e^{py}+A_8 e^{-py})$
$u(x,y)=(A_9x+A_{10})(A_{11}y+A_{12})$

PART-B

1. (a) Determine the Fourier series for the function f(x) = xcosx in (0,2π) **(AU-A/M 2017)(8)**
(b) Find a Fourier series with period 3 to represent f(x) = $2x-x^2$ in (0,3). **(AU-N/D-2014)(8)**

2. (a) Find the Fourier series expansion of f(x) = 1 for 0<x< π
= 2 for π<x<2π **(AU-N/D-2013)(8)**
(b)Find the Fourier series expansion the following periodic function of period 4
f(x) = 2+x , -2≤x≤0
= 2-x , 0<x≤2. Hence deduce that $\frac{1}{1^2}+\frac{1}{3^2}+\frac{1}{5^2}---- \infty=\frac{\pi^2}{8}$ **(AU-A/M-2015)(8)**

3. (a) Find the Fourier series of f(x) = x in - π <x<π. **(AU-N/D-2016)(8)**
(b)Find the Fourier series for the function f(x) = $|\cos x|$ in - π <x<π. **(AU-A/M-2016)(8)**

4. (a) Determine the Fourier series for the function f(x) = x^2 of period 2π in - π <x<π. Hence deduce the value of $\sum_{n=1}^{\infty}\frac{1}{n^2}$ **(AU A/M 2018)-2-(8)**
(b)Find the half range cosine series expansion of $(x-1)^2$ in 0<x< l. **(AU-N/D-2014)(8)**

5. (a) Find the Fourier series expansion of the periodic function f(x) of the period 2 defined by
f(x) = *l*-x , 0<x≤*l*
= 0 , *l*<x≤2*l* . in (o.2*l*) **(AU-N/D 2017)(8)**

(b) Find the Fourier series for the function f(x) = $|\sin x|$ over the interval (-π,π).
(AU-A/M-2015)(8)

6. (a) Obtain the Fourier series for the function given by f(x) = $\begin{cases} 1+\frac{2x}{l} in -l \le x \le 0 \\ 1-\frac{2x}{l} in 0 \le x \le l \end{cases}$

Hence deduce that $\frac{1}{1^2}+\frac{1}{3^2}+\frac{1}{5^2}+\ldots\ldots\ldots\ldots\ldots=\frac{\pi^2}{8}$ **(AU-N/D-2014)-2(8)**

(b) Expand f(x) = x+x^2 as a Fourier series in (-π,π) and hence deduce the value of

$\frac{1}{1^2}+\frac{1}{2^2}+\frac{1}{3^2}+\ldots$ **(AU- N/D 2017)(8)**

7. (a) Find the half range sine series of f(x) = x cosπx in (0,1). **(AU-N/D-2016)(8)**

(b) Find the half range sine series of f(x) = x , 0<x< π/2

= π –x , π /2 < x < π.

Hence deduce the sum of the series $\sum_{n=1}^{\infty}\frac{1}{(2n-1)^2}$ **(AU-A/M-2017)(8)**

8. (a)Find the half range cosine series for f(x)=x(π -x) in (0, π) **(AU-A/M-2018)(8)**

(b)Find the half range cosine series of f(x) = x in 0<x< π. Hence deduce the value of

$\frac{1}{1^2}+\frac{1}{3^2}+\frac{1}{5^2}+\ldots\ldots\ldots\ldots to\ \infty.$ **(AU- N/D 2017)-2-(8)**

9. A bar, 10cm long with insulated sides, has its ends A and B kept at 20^0C and 40^0C respectively until steady state conditions prevail. The temperature at A is then suddenly raised to 50^0C and at thesame instant that at B is lowered to 10^0C. Find the subsequent temperature at any point of thebar at any time. **(AU-A/M-2018)(16)**

10.A rod of length l has its end A and B kept at 0^0C and 100^0C respectively until steady state conditions prevail. If the temperature at B is reduced suddenly to 75^0C and at the same time the temperature at A raised to 25^0C find the temperature u(x,t) at a distance x from A and at time t. **(AU-N/D 2017) –2(16)**

11. An insulated rod of length l its ends A and B are maintained at 0^0C and 100^0C respectively until steady state conditions prevail. If B is suddenly reduced to 0^0C and maintained so, find the temperature at a distance x from A at time t.**(AU N/D 2017) – 2-(16)**

12. A square plate is bounded by the lines x=0,y=0,x=20,y=20. Its faces are insulated. The temperature along the upper horizontal edge is given u(x,20)=x(20-x) while the other three edges are kept at 0^0C. Find the steady state temperature in the plate. **(AU-N/D- 2014)-2(16)**

13. A square plate is bounded by the lines x=0,y=0,x=*l* and y=*l*, it faces are insulated. The temperature along the upper horizontal edge is given by u(x,*l*)=x(*l*-x) when 0<x<*l* while the other three edges are kept at 0^0C. Find the steady state temperature in the plate. **(AU-N/D- 2013)(16)**

14. A long rectangular plate with insulated surface is l cm wide.If the temperature along one short edge is u(x,0) = k($lx-x^2$) for 0 < x < l,while the other two long edges x = 0 and x= *l* as well as the other short edge are kept at 0^0 C, find the steady state temperature function u(x,y). **(AU-N/D- 2016)(16)**

15.A rectangular plate with insulated surface is 20cm wide and so long compared to its width that it may be considered infinite in the length without introducing an appreciable error. If the

temperature along one short edge x=0 is given by u= $\begin{cases} 10y, 0 \le y \le 510 \\ 10(20-y), 10 \le y \le 20 \end{cases}$ and the

two long
edges as well as the other short edge are kept at 0^0C, find the steady state temperature distribution u(x,y) in the plate. **(AU-A/M -2017) (16)**

EC8394 FUNDAMENTALS OF DATA STRUCTURES IN C

2 MARK QUESTIONS WITH ANSWERS
UNIT-I
C PROGRAMMING BASICS

1. Define computers?

A computer is a programmable machine or device that performs pre-defined or programmed computations or controls operations that are expressible in numerical or logical terms at high speed and with great accuracy. (Or) Computer is a fast operating electronic device, which automatically accepts and store input data, processes them and produces results under the direction of step by step program.

2. What are the basic operations of computer?

1. Input
2. Process
3. Storing
4. Controlling and
5. Output.

3. What are the characteristics of computer?

1. Speed
2. Accuracy
3. Automation
4. Endurance
5. Versatility
6. Storage and
7. Cost reduction

4.What are the different types of ROM?

1. Masked ROM,
2. PROM
3. EPROM
4. EEPROM
5. Flash ROM

5. Define system software.

A set of program that governs the operation of a computer system and makes the hardware works. It controls the internal operations of the computer.

6. Define operating system?

A collection of program used to control the entire operation of the computer. It co-ordinates the hardware and software.

7.What is application software?

Software which is used to solve a specific task is called application software.

8. What is Algorithm? List out the way how algorithm may be represented?

Algorithm means the logic of a program. It is a step by step description of a program.

· Normal English
· Flow chart
· Pseudocode
· Decision table

9. Define compiler & Compilation process.

It is a program used to convert the high level language program into machine language.

Compilation refers to the processing of source code files (.c, .cc, or .cpp) and the creation of an 'object' file. This step doesn't create anything the user can actually run. Instead, the compiler merely produces the machine language instructions that correspond to the source code file that was compiled.

10.Define Assembler.

It is a program used to convert the assembly language program into machine language.

11. Define Interpreter.

It is a program used to convert the high level language program into machine language line by line.

12.What is meant by global variable?

The variable that is used in more than one function throughout the program are called global variables and declared outside of all the function.

13.What is meant by tokens?

The tokens are usually referred as individual text and punctuation in the passage of text. The C language program can contain the individual units called the C tokens.

14. What is meant by local variable?

The variables which are defined inside a function block or inside a compound statement of a function sub-program are called local variables.

15. What is Size of operator in C?

Size of is unary operator used to calculate the sizes of data types, this operator can be applied to all data types. The size of operator is used to determine the amount of memory space that the variable/expression/ data type will take. For example, int a=10, result Result=size of (a); Output: Result=2. Since a is integer, it requires 2 bytes of storage space.

16.What are the different data types available in 'C'?

There are four basic data types available in 'C'.

1. int
2. float
3. char
4. double

17. Differentiate break and continue statement

S No	break	continue
1	Exits from current block / loop	Loop takes next iteration
2	Control passes to next statement	Control passes to beginning of loop
3	Terminates the program	Never terminates the program

18. Distinguish between while..do and do..while statement in C. (JAN 2009)

While..DO **DO..while**

(i) Executes the statements within the while block if only the condition is true.	(i) Executes the statements within the while block at least once.
(ii) The condition is checked at the starting of the loop	(ii) The condition is checked at the end of the loop

19.What is a volatile and non-volatile memory?

Volatile memory: also known as volatile storage is computer memory that requires power to maintain the stored information, unlike non-volatile memory which does not require a maintained power supply. It has been less popularly known as temporary memory. Non-volatile memory: nonvolatile memory, NVM or non-volatile storage, is computer memory that can retain the stored information even when not powered.

20.What is the difference between scanf() and gets() function?

In scanf() when there is a blank was typed, the scanf() assumes that it is an end. gets () assumes the enter key as end. That is gets () gets a new line (\n) terminated string of characters from the keyboard and replaces the '\n' with '\0'.

21.Define macro with an example

A Macro is typically an abbreviated name given to a piece of code or a value. Macros can also be defined without any value or piece of code but in that case they are used only for testing purpose.

```
#include #define MACRO1
#define MACRO2
int main(void)
{
#ifdef MACRO1 // test whether MACRO1 is defined...
printf("\nMACRO1 Defined\n");
#endif #ifdef MACRO2 // test whether MACRO2 is defined...
printf("\nMACRO2 Defined\n");
#endif return 0; }
```

22. What is pseudo code?

"Pseudo" means imitation of false and "code" refers to the instruction written in the programming language. Pseudo code is programming analysis tool that is used for planning program logic.

23. What is Flowchart?

A Flowchart is a pictorial representation of an algorithm. It is often used by programmer as a program planning tool for organizing a sequence of step necessary to solve a problem by a computer.

24. Define Constants in C. Mention the types.

The constants refer to fixed values that the program may not alter during its execution. These fixed values are also called literals. Constants can be of any of the basic data types like an integer constant, a floating constant, a character constant, or a string literal. There are also enumeration constants as well. The constants are treated just like regular variables except that their values cannot be modified after their definition.

25. What do you meant by linking?

Linking refers to the creation of a single executable file from multiple object files. In this step, it is common that the linker will complain about undefined functions (commonly, main itself). During compilation, if the compiler could not find the definition for a particular function, it would just assume that the function was defined in another file. If this isn't the case, there's no way the compiler would know it doesn't look at the contents of more than one file at a time. The linker, on the other hand, may look at multiple files and try to find references for the functions that weren't mentioned.

26. Differentiate between formatted and unformatted you input and output functions?

Formatted I/P functions: These functions allow us to supply the input in a fixed format and let us obtain the output in the specified form. Formatted output converts the internal binary representation of the data to ASCII characters which are written to the output file. Unformatted I/O functions: There are several standard library functions available under this category-those that can deal with a string of characters. Unformatted Input/Output is the most basic form of input/output. Unformatted input/output transfers the internal binary representation of the data directly between memory and the file.

27. What is an array?

An array is a group of similar data types stored under a common name. An array is used to store a collection of data, but it is often more useful to think of an array as a collection of variables of the same type. Example: int a[10]; Here a[10] is an array with 10 values.

28. How to initialize an array?

You can initialize array in C either one by one or using a single statement as follows: double balance[5] = {1000.0, 2.0, 3.4, 17.0, 50.0}; The number of values between braces { } cannot be larger than the number of elements that we declare for the array between square brackets [ ].

29. Define Strings.

Strings: The group of characters, digit and symbols enclosed within quotes is called as Stirng (or) character Arrays. Strings are always terminated with '\0' (NULL) character. The compiler automatically adds '\0' at the end of the strings. Example: char name[]={'C','O','L','L','E','G','E','E','\0'};

30. Mention the various String Manipulation Functions in C.

S.N.	Function	Purpose
1 .	strcpy(s1, s2);	Copies string s2 into string s1.
2.	strcat(s1, s2);	Concatenates string s2 onto the end of string s1.
3.	strlen(s1);	Returns the length of string s1.
4.	strcmp(s1, s2);	Returns 0 if s1 and s2 are the same; less than 0 if s1s2.
5.	strchr(s1, ch);	Returns a pointer to the first occurrence of character ch in string s1.
6.	strstr(s1, s2);	Returns a pointer to the first occurrence of string s2 in string s1.

31. What is the use of 'typedef''?

It is used to create a new data using the existing type.
Syntax: typedef data type name;
Example: typedef int hours:
hours hrs;/* Now, hours can be used as new datatype */

32. What is meant by Sorting?

Sorting refers to ordering data in an increasing or decreasing fashion according to some linear relationship among the data items. Sorting can be done on names, numbers and records.

33. Define Searching.

Searching for data is one of the fundamental fields of computing. Often, the difference between a fast program and a slow one is the use of a good algorithm for the data set. Naturally, the use of a hash table or binary search tree will result in more efficient searching, but more often than not an array or linked list will be used. It is necessary to understand good ways of searching data structures not designed to support efficient search.

34Give the syntax for the ‘for’ loop statement
for (Initialize counter; Test condition; Increment / Decrement)
{
statements;
}

13 MARKS QUESTIONS

UNIT I

1. Initialization counter sets the loop to an initial value.
2. This statement is executed only once.
3. The test condition is a relational expression that determines the number of iterations desired or it determines when to exit from the loop.
4. The ‘for’ loop continues to execute as long as conditional test is satisfied.
5. When condition becomes false, the control of program exists the body of the ‘for’ loop and executes next statement after the body of the loop.
6. Describe the structure of a C Program.
7. List the different data types available in C.
8. What are constants? Explain the various types of constants in C.
9. Explain the different types of operators available in C.
10. Describe the various looping statements used in C with suitable examples.
11. Explain about various decision making statements available in C with illustrative programs.

12. Write the operations of compilation process.
13. Write a C program to print the Fibonacci series of a given number.
14. Write a C program to solve the quadratic equation and to find a Factorial of a given number.

15. Write a C program to check whether a given number is prime number or not.
16. What is an array? Discuss how to initialize a one dimensional and two dimensional arrays with suitable example?
17. Write a C program to search an element in a given array using linear and binary search.
18. Write a C program for sorting an array of numbers using selection sort.
19. Write a C program to addition, subtract and multiply two matrices.
20. Write a C program to scaling transformations of a matrix.
21. Write a C program to determinant a matrix.
22. Write a C program to transpose a matrix.
23. Write a C program to find mean, median and mode.
24. Explain in detail about string and list the various string operations with example.
    Write a C program to find out the length and reverse of the string without using built-in function.

UNIT-II
FUNCTIONS, POINTERS, STRUCTURES AND UNIONS

1.What are functions in C? How will define a function in C?

A function is a group of statements that together perform a task. Every C program has at least one function which is main(), and all the most trivial programs can define additional functions.

Defining a Function:
The general form of a function definition in C programming language is as follows:

```
return_type function_name( parameter list )
 {
body of the function
 }
```

2.Distinguish between Call by value Call by reference.

Call by value:

a) In call by value, the value of actual agreements is passed to the formal arguments and the operation is done on formal arguments.
b) Formal arguments values are photocopies of actual arguments values.
c) Changes made in formal arguments valued do not affect the actual arguments values.

Call by reference:

a) In call by reference, the address of actual argument values is passed to formal argument Values.
b) Formal arguments values are pointers to the actual argument values.
c) Since Address is passed, the changes made in the both arguments values are permanent

3. What is meant by Recursive function?

If a function calls itself again and again, then that function is called Recursive function.
Example:

```
void recursion()
 {
recursion(); /* function calls itself */
}


int main()
{
 recursion();
 }
```

4. What is a Pointer and how it is declared? What are the uses of Pointers?

Pointer is a variable which holds the address of another variable.
Pointer Declaration:
data type *variable-name;
Example:
int *x, c=5; x=&a;
Uses of Pointers
Pointers are used to return more than one value to the function ·
Pointers are more efficient in handling the data in arrays ·
Pointers reduce the length and complexity of the program ·
They increase the execution speed ·
The pointers save data storage space in memory

5. Write short notes on null pointer.

Null Pointer:
It is a special pointer value that is known not to point anywhere, this means that the null pointer does not to point to any valid memory address
E.g.: int * ptr=NULL;

6. Compare arrays and structures.

Arrays	**Structures**
An array is a collection of data items of same data type. Arrays can only be	A structure is a collection of data items of different

declared.	data types. Structures can be declared and defined.
There is no keyword for arrays.	The keyword for structures is struct.
An array cannot have bit fields.	A structure may contain bit fields.

7. Compare structures and unions.

Structure	Union
Every member has its own memory.	All members use the same memory.
The keyword used is struct.	The keyword used is union.
All members occupy separate memory location, hence different interpretations of the same memory location are not possible.	Different interpretations for the same memory location are possible.

8. Define Structure in C.

C Structure is a collection of different data types which are grouped together and each element in a C structure is called member.

If you want to access structure members in C, structure variable should be declared. Many structure variables can be declared for same structure and memory will be allocated for each separately.

It is a best practice to initialize a structure to null while declaring, if we don't assign any values to structure members.

9. What is dynamic memory allocation? What are the various dynamic memory allocation functions?

Allocating the memory at run time is called as dynamic memory allocation.

malloc() - Used to allocate blocks of memory in required size of bytes.
free() - Used to release previously allocated memory space.
calloc() - Used to allocate memory space for an array of elements.
realloac () - Used to modify the size of the previously allocated memory space.

10.What is meant by Union in C.?

A union is a special data type available in C that enables you to store different data types in the same memory location. You can define a union with many members, but only one member can contain a value at any given time. Unions provide an efficient way of using the same memory location for multi-purpose.

To define a union, you must use the union statement in very similar was as you did while defining structure. The union statement defines a new data type, with more than one member for your program.

The format of the union statement is as follows:

```
union [union tag]
{
member definition;
member definition;
...
member definition;
}
[one or more union variables];
```

11. What are the pre-processor directives?

Macro Inclusion
Conditional Inclusion
File Inclusion

12. What are storage classes?

A storage class defines the scope (visibility) and life time of variables and/or functions within a C Program.

13. What are the storage classes available in C?

There are following storage classes which can be used in a C Program auto, register, static, and extern.

14. What is register storage in storage class?

Register is used to define local variables that should be stored in a register instead of RAM. This means that the variable has a maximum size equal to the register size (usually one word) and cant have the unary '&' operator applied to it (as it does not have a memory location).

```
{
register int Miles;
}
```

15. What is static storage class?

Static is the default storage class for global variables.

The two variables below (count and road) both have a static storage class.

```
static int Count;
int Road;
{
printf("%d\n", Road);
}
```

16. Define Auto storage class in C.

Auto is the default storage class for all local variables.

```
{
int Count;
auto int Month;
}
```

The example above defines two variables with the same storage class. auto can only be used within functions, i.e. local variables.

15. Define pre-processor in C.

The C Preprocessor is not part of the compiler, but is a separate step in the compilation process. In simplistic terms, a C Preprocessor is just a text substitution tool.

We'll refer to the C Preprocessor as the CPP.

Example:

#define Substitutes a preprocessor macro

#include Inserts a particular header from another file

Define Macro in C. A macro definition is independent of block structure, and is in effect from the #define directive that defines it until either a corresponding

#undef directive or the end of the compilation unit is encountered. Its format is:

#define identifier replacement Example:

```
#define TABLE_SIZE 100 int table1[TABLE_SIZE];
int table2[TABLE_SIZE];
```

16. What are conditional Inclusions in Pre-processor Directive?

Conditional inclusions (#ifdef, #ifndef, #if, #endif, #else and #elif)

These directives allow including or discarding part of the code of a program if a certain condition is met.

#ifdef allows a section of a program to be compiled only if the macro that is specified as the parameter has been defined, no matter which its value is.

For example:

```
#ifdef TABLE_SIZE
int table [TABLE_SIZE];
#endif
```

UNIT II-Part-B

1. What is a function in C? Explain the steps in writing a function in C program with example.
2. Classify the function prototypes with example C program for each.
3. What is recursion? Write a C program to find the sum of the digits, to find the factorial of a number and binary search using recursion.
4. Write a C program to design the scientific calculator using built-in functions.
5. Explain about pointers and write the use of pointers in arrays with suitable example.
6. Explain the concept of pass by value and pass by reference. Write a C program to swap the content of two variables using pass by reference.
7. What is a structure? Create a structure with data members of various types and declare two structure variables. Write a program to read data into these and print the same. Justify the need for structured data type.
8. Write a C program to store the employee information using structure and search a particular employee using Employee number.
9. Define and declare a nested structure to store date, which including day, month and year.
10. Explain about array of structures and pointers in structures with example program.
11. Write a C program to create mark sheet for students using self referential structure.
12. Discuss about dynamic memory allocation with suitable example C program.
13. Explain about singly linked list with suitable example C program.

UNIT-III
LINEAR DATA STRUCTURES

1. Define data structure.

The organization, representation and storage of data is called the data structure. Since all programs operate on data, a data structure plays an important role in deciding the final solution for the problem.

2. Define linear data structures.

Linear data structures are data structures having a linear relationship between its adjacent elements. Linked lists are examples of linear data structures.

3.What is meant by a linked list? What are the advantages of a linked list? (June-2014)

Linear list is defined as, item in the list called a node and contains two fields, an information field and next address field. The information field holds the actual element on the list. the next address field contains the address of the next node in the list.
It is necessary to specify the number of elements in a linked list during its declaration. Linked list can grow and shrink in size depending upon the insertion and deletion that occurs in the list.
Insertion and deletion at any place in a list can be handed easily and efficiently.
A linked list does not waste any memory space.

4.What are the operations can we perform on a linked list?

The basic operations that can be performed on linked list are,

Creation of a list.
Insertion of a node. Modification
of a node. Deletion of a node.

Traversal of a node.

13. What are the applications of linked list?

Linked list form the basis of many data structures, so it's worth looking at some applications that are implemented using the linked list.

Some important application using linked list are

Stacks

Queues

14. Define static data structures. List some of the static data structures in C.

A data structure formed when the number of data items are known in advance is referred as static data structure or fixed size data structure.

Some of the static data structures in C are arrays, pointers, structures etc.

15. What is a singly listed list?

The singly linked list, in which each node has a single link to its next node. This list is also referred as a linear linked list. The head pointer points to the first node in the list and the null pointer is stored in the link field of the last node in the list.

16.What is a double linked list?

Doubly linked list is an advanced form of a singly linked list, in which each node contains three fields namely,

Previous address field.

Data field.

Next address field.

The previous address field of a node contains address of its previous node. The data field stores the information part of the node. The next address field contains the address of the next node in the list.

17.What are the two basic types of Data structures?

1. Primitive Data structure
   Eg., int,char,float
2. Non Primitive Data Structure
   i. Linear Data structure
   Eg., Lists Stacks Queues
   ii. Non linear Data structure
   Eg., Trees Graphs

18.State the applications of stack.

1. Balancing parentheses.
2. Postfix Expression.
   i. Infix to postfix conversion
3. Function calls.

19.Define queue with examples.

Queue is a list in which insertion is done at one end called the rear and deletion is performed at another called front. e.g: Ticket counter.

Phone calls waiting in a queue for the operator to receive.

20.List the operations of queue.

Two operations

1. Enqueue-inserts an element at the end of the list called the rear.
2. Dequeue-delets and returns the element at the start of the list called as the front.

21. List the Applications of queue?

- Graph Algorithm
- Priority Algorithm
- Job scheduling

22. Define priority queue with diagram and give the operations.

Priority queue is a data structure that allows at least the following two operations.
1. Insert-inserts an element at the end of the list called the rear.
2. DeleteMin-Finds, returns and removes the minimum element in the priority Queue.
   Operations: Insert DeleteMin

23. Give the applications of priority queues.

There are three applications of priority queues

1. External sorting.
2. Greedy algorithm implementation.
3. Discrete even simulation.
4. Operating systems.

24. List out the basic operations that can be performed on a stack

The basic operations that can be performed on a stack are

- Push operation
- Pop operation
- Peek operation
- Empty check
- Fully occupied check

25. Define a queue

Queue is an ordered collection of elements in which insertions are restricted to one end called the rear end and deletions are restricted to other end called the front end. Queues are also referred as First-In-First-Out (FIFO) Lists.

26. Define a stack

Stack is an ordered collection of elements in which insertions and deletions are restricted to one end. The end from which elements are added and/or removed is referred to as top of the stack. Stacks are also referred as piles, push-down lists and last-in-first-out (LIFO) lists.

27. List the applications of stacks

- Towers of Hanoi
- Reversing a string
- Balanced parenthesis
- Recursion using stack
- Evaluation of arithmetic expressions

28. List the applications of queues

- Jobs submitted to printer
- Real life line
- Calls to large companies
- Access to limited resources in Universities
- Accessing files from file server

29. What is meant by an abstract data type(ADT)?

An ADT is a set of operation. A useful tool for specifying the logical properties of a datatype is the abstract data type. ADT refers to the basic mathematical concept that defines the datatype.

Eg. Objects such as list, set and graph along their operations can be viewed as ADT's

UNIT III –Part-B

1. Write a C program to perform addition operation on polynomial using linked list.
2. Describe the creation of doubly linked list and appending the list.Give relevant code in C.

3. Write an algorithm to convert an infix expression to a postfix expression .Trace the algorithm to convert the infix expression "(a+b)*c/d+e/f" to postfix expression. Explain the need for infix and postfix expressions.
4. Illustrate the algorithm to create singly linked list and perform the operations on the created list.
5. Explain Array implementation of Queue.
6. Explain Linked List Implementation of Stack.
7. Explain Linked List Implementation of Queue.
8. Explain array implementation of stack.

UNIT-IV
NON-LINEAR DATA STRUCTURES

1. Define non-linear data structure.

Data structure which is capable of expressing more complex relationship than that of physical adjacency is called non-linear data structure.

2. Define a tree.

A tree is a non-linear, two-dimensional data structure, which represents hierarchical relationship between individual data items.

3.Define a full binary tree.

A full binary tree is a tree in which all leaves are on the same level and every non-leaf node has exactly two children.

4. Define a complete binary tree.

A complete binary tree is a tree in which every non-leaf node has exactly two children not necessarily to be on the same level.

5. What is meant by binary tree traversal? What are the different binary tree traversal techniques?

Traversing a binary tree, means moving through all the nodes in the binary tree, visiting each node in the tree only once.

The different binary tree traversal techniques are,

1. Preorder traversal
2. Inorder traversal
3. Postorder traversal
4. Levelorder traversal

6. Define a binary search tree.

A binary search tree is a special binary tree, which is either empty or if it is empty it should satisfy the following characteristics.

1. Every node has a value and no two nodes should have the same value(i.e., the values in the binary search tree are distinct.
2. The values in any left subtree is less than the value of its parent node.
3. The values in any right subtree is greater than the value of its parent node.
4. The left and right subtrees of each node are again binary search trees.

7.Define a graph.

A graph is a non-linear data structure that represents less relationship between its adjacent elements. There is no hierarchical relationship between the adjacent elements in case of graphs.

8.List the two types of graphs.

1. Directed graph
2. Undirected graph

Undirected graph

If an edge between any two nodes in a graph is not directionally oriented a graph is called as undirected graph. It is also referred as unqualified graph.

Directed graph.

If an edge between any two nodes in a graph is directionally oriented, a graph is called as directed graph; it is also referred as a digraph.

9. What is meant by traversing a graph? State the different ways of traversing a graph.

Traversing a graph means visiting all the nodes in the graph. In many practical applications traversing a graph is important, such that each vertex is visited once systematically by traversing through minimum number of paths. The two important graph traversal methods are,

1. Depth-first traversal (or) Depth-first search(DFS)
2. Breath-first traversal (or) Breath-first search(BFS)

10. Define DFS.

DFS means Depth First search it is like a preorder traversal of a tree. It is continuous searching for the unvisited nodes in the forward direction based on the recursive process.

11. Define adjacency matrix.

Adjacency matrix is a representation used to represent a graph with zeros and ones. A graph containing n vertices can be represented by a matrix with n rows n columns. The matrix is formed by storing 1 in its i^{th} row and j^{th} coilumn of the matrix, if there exists an edge between i^{th} and j^{th} vertex of the graph, and a 0, if there is no edge between i^{th} and j^{th} vertex of the graph.

12. Define adjacency list.

A graph containing m vertices and n edges can be represented using a linked list, referred to as adjacency list.

13. What are the two traversal strategies used in traversing a graph?

a. Breadth first search

b. Depth first search

14. Differentiate BFS and DFS.

No.	**DFS**	**BFS**
1	Backtracking is possible from a dead end	Backtracking is not possible
2	Vertices from which exploration is incomplete are processed in a LIFO order	The vertices to be explored are organized as a FIFO queue
3	Search is done in one particular direction	The vertices in the same level are maintained parallelly

15. What do you mean by articulation point?

If a graph is not biconnected, the vertices whose removal would disconnect the graph are known as articulation points.

16. Name the different ways of representing a graph?

1. Adjacency matrix
2. Adjacency list

17. What is a directed graph?

A graph in which every edge is directed is called a directed graph.

18. What is an undirected graph?

A graph in which every edge is undirected is called a directed graph.

19. Define adjacent nodes.

Any two nodes which are connected by an edge in a graph are called adjacent nodes. For example, if an edge x ε E is associated with a pair of nodes (u,v) where u, v ε V, then we say that the edge x connects the nodes u and v.

20. What is a weighted graph?

A graph in which weights are assigned to every edge is called a weighted graph.

21. Define outdegree of a graph?

In a directed graph, for any node v, the number of edges which have v as their initial node is called the out degree of the node v.

22. Define indegree of a graph?

In a directed graph, for any node v, the number of edges which have v as their terminal node is called the indegree of the node v.

23. What do you mean by breadth first search (BFS)?

BFS performs simultaneous explorations starting from a common point and spreading out independently.

UNIT IV
NON-LINEAR DATA STRUCTURES

1. List the application of trees.
2. Briefly explain the binary search tree and write the routines.
3. Briefly explain the tree traversal with algorithms.
3. Explain the graph traversal in details.
4. Explain Breadth First and Depth Search First Search algorithm.
5. Explain the set, union, find operations in Non linear data structures.
6. Apply your understanding to explain about binary search tree and draw the binary search tree for the following input list 60, 25,75,15,50,66,33,44. Trace an algorithm to delete the nodes 25, 75, 44 from the tree.

UNIT V-PART-B

1. What is meant by sorting?

Ordering the data in an increasing or decreasing fashion according to some relationship among the data item is called sorting.

2. What are the two main classifications of sorting based on the source of data?

1. Internal sorting
2. External sorting

3. What is meant by external sorting?

External sorting is a process of sorting in which large blocks of data stored in storage Devices are moved to the main memory and then sorted.

4. What is meant by internal sorting?

Internal sorting is a process of sorting the data in the main memory.

5. What are the various factors to be considered in deciding a sorting algorithm?

1. Programming time
2. Execution time of the program
3. Memory needed for program environment

6. What is the main idea in Bubble sort?

The basic idea underlying the bubble sort is to pass through the file sequentially Several times. Each pass consists of comparing each element in the file with its successor (x[i] and x[i+1] and interchanging the two elements if they are not in proper order.

7. What is the basic idea of shell sort?

Instead of sorting the entire array at once, it is first divide the array into smaller segments, which are then separately sorted using the insertion sort.

8. What is the purpose of quick sort?

The purpose of the quick sort is to move a data item in the correct direction, just enough for to reach its final place in the array.

9. What is the advantage of quick sort?

Quick sort reduces unnecessary swaps and moves an item to a greater distance, in one move.

10. What is the average efficiency of heap sort?

The average efficiency of heap sort is O (n (log2 n)) where, n is the number of elements sorted.

11. How many passes are required for the elements to be sorted in insertion sort?

One of the simplest sorting algorithms is the insertion sort. Insertion sort consist of N-1 passes. For pass P=1 through N-1 , insertion sort ensures that the elements in positions 0 through P-1 are in sorted order .It makes use of the fact that elements in position 0 through P-1 are already known to be in sorted order.

12. What is maxheap?

If we want the elements in the more typical increasing sorted order, we can change the ordering property so that the parent has a larger key than the child. it is called max heap.

13. Mention some methods for choosing the pivot element in quick sort?

1. Choosing first element
2. Generate random number
3. Median of three

14. What are the three cases that arise during the left to right scan in quick sort?

1. I and j cross each other

2. I and j do not cross each other
3. I and j points the same position

15. What are the properties involved in heap sort?

1. Structure property
2. Heap order property

16. What is the time complexity of binary search?

The best case complexity is O (1) i.e if the element to search is the middle element. The average and worst case time complexity are O(log n).

17. List sorting algorithm which uses logarithmic time complexity.

1. Merge sort
2. Heap sort
3. Shell ort

UNIT V
SEARCHING AND SORTING ALGORITHMS

1. Explain the sorting algorithms
2. Explain the searching algorithms
3. Explain hashing
4. Explain open addressing
5. Write a C program to sort the elements using bubble sort.
6. Write a C program to perform searching operations using linear and binary search.
7. Explain in detail about separate chaining.
8. Explain hashing with example.
9. Explain collision resolution strategies?
10. How to handling the overflow handling in Hash Tables?

EC 8351-ELECTRONICS CIRCUITS-I

UNIT I BIASING OF DISCRETE BJT, JFET AND MOSFET

PART A TWO MARKS QUESTIONS AND ANSWERS

1. What are the transistor parameters that vary with the temperature?

β,I_{CO},V_{Beo} are the parameters varying with the temperature.

2. What is Bias? What is the need for biasing?

The proper flow of zero signal collector current and the maintenance of proper collector emitter voltage during the passage of signal is known as transistor biasing. When a transistor is biased properly, it works efficiently and produces no distortion in the output signal and thus operating point can be maintained stable.

3. What do you understand by DC & AC load line?

DC Load Line

It is the line on the output characteristics of a transistor circuit which gives the values of I_c & V_{ce} corresponding to zero signal (or) DC Conditions.

AC Load Line

This is the line on the output characteristics of a transistor circuit which gives the values of I_c & V_{ce} when signal is applied.

4. What is meant by operating point Q?

The zero signal values of I_c & V_{ce} are known as operating point. It is also called so because the variations of I_c and V_{ce} take place about this point, when the signal is applied.

5. What are the types of biasing?

The different types of biasing are

(i) Fixed bias
(ii) Collector to Base bias (or) Feedback bias
(iii) Self bias (or) Voltage divider bias

6. What are all the factors that affect the stability of the operating point?

The following are the factors that affect the stability of the operating point,

a. Change of due to replacement of transistors.
b. Thermal variations

7. Define stability factor 'S'.

The stability factor is defined as the rate of change of collector current I_c with respect to the reverse saturation collector current I_{co}, keeping 'V_{be}' and '' constant.

$$S = \frac{\Delta I_c}{\Delta I_{co}}$$

8. What are the disadvantages of collector feedback bias?

The disadvantages of feedback bias are

a. The collector current is high.
b. If AC signal voltage gain feedback into the resistor Re, it will reduce the gain of the amplifier.

9. Why voltage divider bias is commonly used in amplifier circuit?

The voltage divider bias has the following advantages

a. Operating point will be in stable position.
b. The stability will be considerably improved.
c. I_c can be reduced to the collector leakage current I_{CO}.

10. Define the stability factors S' and S''?

The Stability factor S' is defined as the rate of change of I_c with V_{BE} keeping I_{CO} and constant.

$$S' = \frac{\Delta I_c}{\Delta V_{BE}}$$

The Stability factor S'' is defined as the rate of change of I_c with keeping V_{BE} and I_{CO} constant.

$$S'' = \frac{\Delta I_c}{\Delta \beta}$$

11. Give the stability factor S for the fixed bias circuit.

The stability factor for the fixed bias circuit is,

$$S = 1 + \beta$$

12. Give the stability factor S for the Collector to base bias circuit.

The stability factor for the Collector to base bias circuit is,

$$S = \frac{1+\beta}{1-\beta\,[\,Rc/(Rc+Rb)\,]}$$

13. Give the stability factor S for the Voltage divider bias circuit.

The stability factor for the Voltage divider bias circuit is,

$$S = \frac{1+\beta}{1-\beta\,[\,Rc/(Rc+Re)\,]}$$

14. Why fixed bias circuit is not used in practice?

The stability of the fixed bias circuit is very less. Since the stability factor S = 1+β, is a large quantity, therefore stability is less. So, it is not used in amplifier circuits.

15. What are all the compensation techniques used for bias stability?

Along with the negative feedback, the following techniques are used for the Q point stability.

a. Diode compensation,
b. Thermistor compensation,
c. Sensistor compensation.

16. Why the input impedance of FET is more than that of a BJT?

The input impendence of FET is more than that of a BJT because the input circuit of FET is reverse biased whereas the input circuit of BJT is forward biased.

17. How FET is known as Voltage variable resistor?

In the region before pinch off, where V_{DS} is small, the drain to source resistance r_d can be controlled by the bias voltage VGS. Therefore FET is used as voltage variable resistor (VVR) or Voltage dependent Resistor (V_{DR})

18. List the advantages of Fixed bias method?

The advantages of fixed bias method are,

a. The stability of the operating point is greatly improved when compared with the other circuits.
b. Less cost and simple circuit.

19. How self-bias circuit is used as constant current source?

In the self bias circuit if I_c tends to increase because of I_{CO} has increasing as a result of temperature, the current in R_E increases. As a consequence of the increase in voltage drop across R_E that provides negative feedback, the base current is decreased. Hence constant I_C value is maintained in the self bias circuit

20. What is Thermal runaway?

The continuous increase in collector current due to poor biasing cause the temperature at collector terminal to increase. If no stabilization is done, the collector leakage current also increases. This further increases the temperature. This action becomes cumulative and ultimately the transistor burns out. The self destruction of an unstabilised transistor is known as thermal runaway.

21. What are the consideration factors that are used for the selection of an operating point for an FET amplifier?

The consideration factors are,

a. Output voltage swing,
b. Distortion,
c. Power dissipation,

d. Voltage gain,
e. Drift (or) Drain current.

22. Write the different types of FET biasing circuits.

The FET biasing circuits are classified as,

a. Gate bias,
b. Self bias
c. Voltage divider bias,
d. Current source bias
e. Drain feedback bias
f. Zero bias.

23. What is meant by stabilization?

The maintenance of the operating point fixed stable is known as stabilization.

PART B

1. How is dc and ac load line draw on the output characteristic curves of on the output characteristics
2. curves of an amplifier sketch them &discuss
3. Explain thermistor compensation technique with neat diagram and explain self bias circuit using n-channel JFET
4. Derive expression for the various stability factors
5. Explain in detail about voltage divider bias circuit for FET
6. What is the need for biasing .explain the different types of biasing of BJT?
7. Explain in detail about collector to base bias circuit of FET
8. Define 3 stability factors derive& explain the condition to avoid thermal run away
9. Describe the stability in fixed &self bias& compare their performance
10. Explain in detail about biasing of MOSFET
11. Show how a FET can be used as a voltage variable resistor
12. Draw the dc load line for the following transistor configuration obtain the quiescent point
13. RC=330Ω, rb1=5.2k, rb2=1.24k, re=100Ω&B=100 Ω

UNIT II BJT AMPLIFIERS
PART A

1. What is an amplifier?

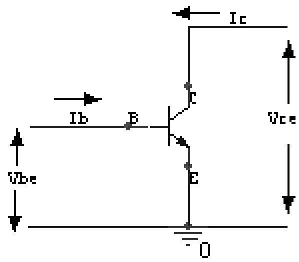
An amplifier is a circuit, which can be used to increase the amplitude of the input current or voltage at the output by means of energy drawn from an external source.

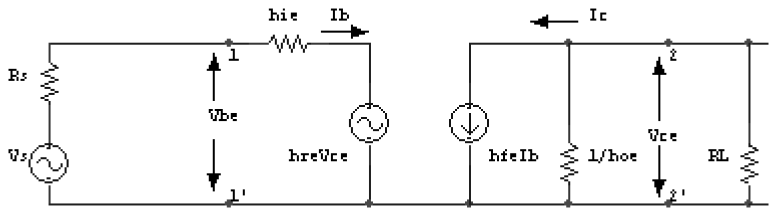
2. Based on the transistor configuration how amplifiers are classified.

Based on transistor configuration, the amplifier are classified as

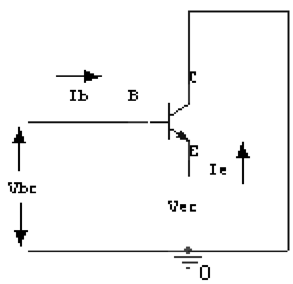
a. Common Emitter amplifier
b. Common Collector amplifier
c. Common Base amplifier

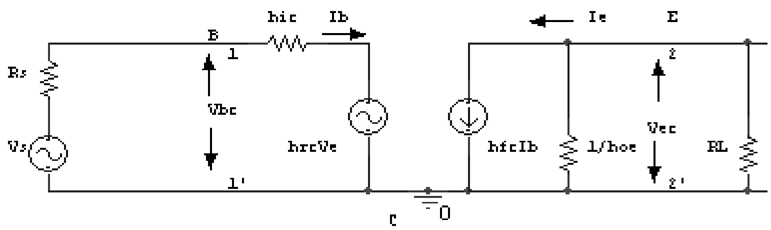
3. Draw a CE amplifier & its hybrid equivalent circuit.



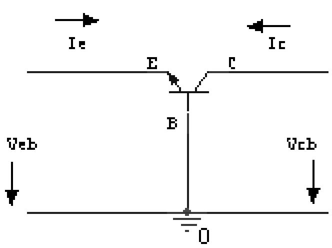


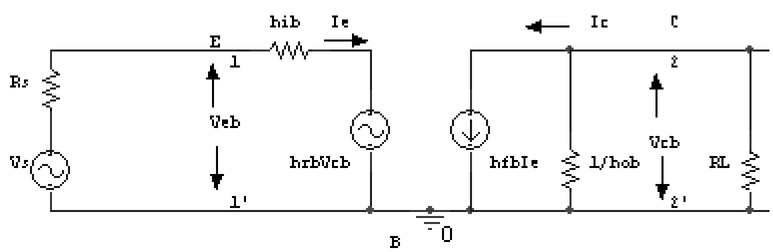
4. Draw a CC amplifier & its hybrid equivalent circuit





5. Draw a CB amplifier & its hybrid equivalent circuit





6. Write the Hybrid parameters equation for transistor amplifier?

$V_i = h_i I_i + h_r V_o$
$I_o = h_f I_i + h_o V_o$

7. Write the CE amplifier Current gain, Voltage gain, Input Impedance, Output Impedance in terms of h-parameters.

Current gain $A_i = -h_{fe}$
Voltage gain $A_v = (- h_{fe} R_L)/h_{ie}$
Input Impedance $Z_i = h_{ie}$
Output Impedance $Z_o = (h_{fe}+R_s)/(h_{oe}R_s + \Delta h)$

8. Write the current amplification factors of the three transistor amplifier configurations.

In a transistor amplifier with AC input signal, the ratio of change in output current to the change in input current is known as the current amplification factor.

9. Which amplifier is called as voltage follower? Why?

The common collector transistor amplifier configuration is called as voltage follower. Since it has unity voltage gain and because of its very high input impedance. It doesn't draw any input current from the signal. So, the input signal is coupled to the output circuit without making any distortion.

10. Why hybrid parameters are called so? Define them.

The dimensions of the hybrid parameters are not alike, that is they are hybrid in nature so they are called hybrid parameters.

h_{11} = [V_1/I_1] at $V_2=0$; h_{11} = Input impedance with output port short circuited.
h_{12} = [V_1/V_2] at $I_1=0$; h_{12} = Reverse voltage gain with input port open circuited.
h_{21} = [I_2/I_1] at $V_2=0$; h_{11} = Forward current gain with output port short circuited.
h_{22} = [I_2/V_2] at $I_1=0$; h_{11} = output impedance with input port open circuited.

11. What are the salient features of hybrid parameters?

The salient features of hybrid parameters are,

a. h parameters are real numbers,
b. They are easy to measure.
c. They are convenient to use in circuit analysis and design
d. Easily convertible from one configuration to other
e. Readily supplied by manufactures.

12. Write the input impedance, output impedance, voltage gain and current gain of the common emitter amplifier in terms of h parameters for the fixed bias condition.

Current gain $A_i = -h_{fe}$
Voltage gain $A_v = (h_{fe}R_C)/h_{ie}$
Input Impedance $Z_i = h_{ie}$
Output Impedance $Z_o = R_L \|R_C$

13. Give the condition for analyzing the simplified Hybrid model of the transistor amplifier.

The following condition should be satisfied for analyzing the simplified hybrid model of transistor amplifier.

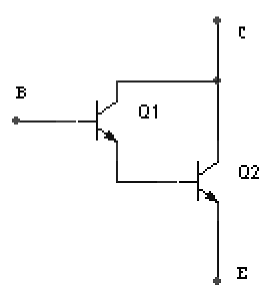
$$h_{oe}.R_L<0.1$$

14. What is a Darlington connection in the amplifiers?

A Darlington transistor connection provides a transistor having a very large current gain, typically a few thousand. The main features of the Darlington connection is that the composite transistor acts as a single unit with a current gain, that is the product of current gains of the individual transistors.

$\beta_D= \beta_1\beta_2$
β_D = Darlington connection current gain
$\beta 1$ and $\beta 2$ – Current gain of the transistors 1 & 2 in the Darlington pair

15. Draw the darlington connections using similar transistors

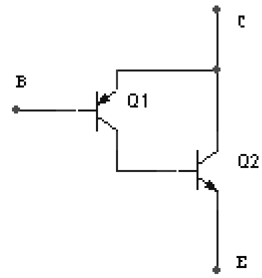


16. State the various methods of improving CMRR?

The methods of improve CMRR are,

a. Constant current bias method
b. Use of current mirror circuit
c. Use of active load

17. Draw the Darlington connection using complementary transistors.



18. What does bootstrapping mean?

In Darlington transistor pair circuits, the input impedance is reduced because of the biasing resistors in the circuit. To overcome this, decrease in the input resistance due to the biasing network, a small capacitor and resistance R_3 are added in the circuit. This improved the input impedance of the darlington pair circuit.

C is added at the input side and R_3 is connected between output and input circuits.

R_{eff} = Effective input resistance.

$R_{eff} = R_3/(1-A_v)$

R_{eff} = Large value

A_v= Voltage gain.

19. Why we go for differential amplifier? (or) What is the need of differential amplifier?

The need for differential amplifier arises in many physical measurements, in medical electronics and in direct coupled amplifier applications. In this amplifier, there will be no output voltage resulting from thermal drifts or any other changes provided, changes in both halves of the circuits are equal.

20. Define Common Mode Rejection Ratio (CMRR).

Common Mode Rejection Ratio is the figure of merit of a differential amplifier and is given by,

$$\text{CMRR} = \frac{\text{Gain of the amplifier for a difference mode input signal}}{\text{Gain of the amplifier for a common mode input signal}}$$

$$C = \left| \frac{A_d}{A_c} \right|$$

21. What are the advantages of differential amplifier?

The advantages of differential amplifier are,

a. Very stable
b. Low noise, low drift,
c. Variations in supply voltage, temperature etc., will not change the gain of the amplitude.
d. Does not require any coupling capacitor.
e. Frequency response is better.

22. What are the applications of a differential amplifier?

The applications of a differential amplifier are,

a. To measure many physical quantities,
b. Can be used as a direct coupled amplifier,
c. Used in operational amplifier.

23. What does bootstrapping technique mean?

If one end of the resistor changes in voltage, the other end of the resistor also moves through the same change in voltage. This technique is known as bootstrapping. It is used to increase the input impedance of the darlington pair circuits.

24. What is a differential amplifier?

An amplifier that has two inputs and produces an output signal that is a function of the difference between the two given inputs is called differential amplifier.

25. Why transformer coupling is not used in the initial stages of a multistage amplifier?

The transformer-coupled amplifiers are not used in the initial stages of a multistage amplifier because it produces unwanted noise. Once these signals are amplified, it cannot be eliminated by the other stages hence the amplifier performance is deteriorates.

26. Write the need for constant current source for difference amplifier.

The necessary for constant current source for differential amplifier to increase the common mode rejection ratio without changing the quiescent current and without lowering the forward current gain.

27. Why constant current source biasing is preferred for differential amplifier?

The constant current source biasing is preferred for differential amplifier in order to increase the input resistance and to make the common mode gain is zero.

28. What is Common mode voltage swing?

The common mode voltage swing is defined as the maximum peak input voltage which may be applied to either the input terminal without causing abnormal operation or damage. Typically with power supplies of +6v or –6V, the common mode voltage swing should not exceed +2v

29. Why Re is replaced by a constant current bias in a differential amplifier?

The emitter supply V_{BE} used for biasing purpose must become larger as R_E is increased in order to maintain the quiescent current at its proper value. If the operating currents of the transistors are allowed to decrease, this will lead to higher hie values and will tend to decrease CMRR. To overcome this practical limitations R_E is replaced by a constant current bias.

30. What is the input impedance of differential amplifier with RE at its emitter junction?

The input impedance of a differential amplifier RL at its emitter junction is

$$R_L= 2h_{ie}+(1+h_{fe})R_E$$

31. What are the special features of a difference amplifier that used FETs?

The special features of difference amplifier using FET are,

a. Very high input impedance.
b. The common mode rejection ability is increased which makes the common gain almost zero.

32. Write the two types of linear differential amplifiers?

The linear differential amplifiers are classified as,

a. Inverting amplifier.
b. Non Inverting amplifier

33. Write the gain equation of inverting amplifier?

The gain equation of inverting amplifier is,

$A_{vf} = V_o/V_{in} = -(R_f/R_i)$
A_{vf}= Gain with feedback
R_f = Feedback path resistor
R_i = Input resistor.

34. Write the configuration of differential amplifier.

The differential amplifier has the following configurations,

a. Dual input, balanced output differential amplifier,
b. Dual input, unbalanced output differential amplifier,
c. Single input, balanced output differential amplifier,
d. Single input, unbalanced output differential amplifier,

35. What do you mean by bisected network?

Consider of a particular network, which has mirror symmetry with respect to an imaginary line. If the entire network is denoted as N, then it can be divided into two half networks N/2 about the line of symmetry as shown below. The two half networks can be connected using any number of wires but the wires are not crossing. This type of network is known as bisected network.

PART B

1. Explain the operation of the emitter coupled differential amplifier and Discuss about the transfer characters of the differential amplifier
2. Explain Darlington circuit with neat sketch.
3. Explain the differential and common mode operation of transistorized differential amplifier.
4. Explain cascade amplifier and derive its parameter.
5. Explain cascode amplifier and derive its parameter.
6. Draw the Darlington emitter follower circuit and explain.
7. Derive the input and output impedance of an emitter follower with its small signal equivalent circuit.
8. Derive the input and output impedance of common emitter amplifier with its small signal equivalent circuit.
9. Derive the input and output impedance of common base amplifier with its small signal equivalent circuit.
10. Employ boot strapping technique in the emitter follower circuit and derive its input impedance.

UNIT III SINGLE STAGE FET AND MOSFET AMPLIFIERS

PART A

1. Give two advantages of common source FET amplifier?

- Good voltage gain
- High input impedance.

2. What is the use of source bypass capacitor in CS amplifier?

Source bypass capacitor in CS amplifier is used for improving the voltage gain.

3. **Why N-channel FET's have a better response than P-channel FET's?**

N-channel FET have a better high frequency response than P-channel FET due to the following reason.

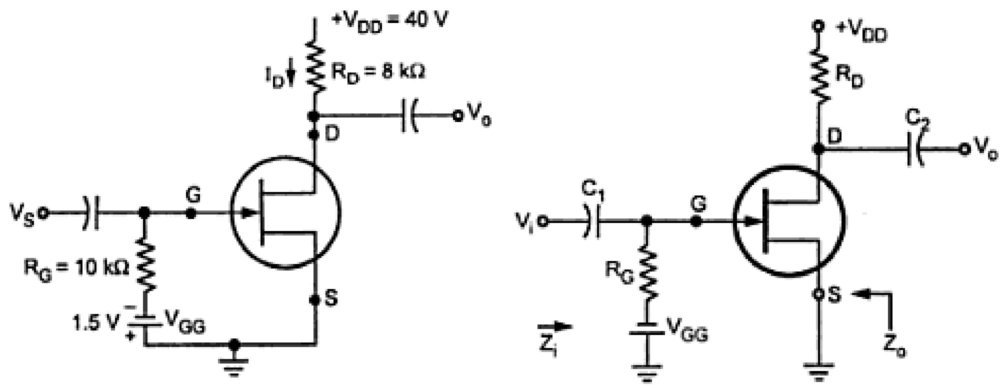
- Mobility of electrons is large in N-channel FET whereas the mobility of holes is poor in P-channel FET.
- The input noise is less in N-channel FET than that of the P-channel FET.
- The transconductance is larger in N-channel FET than that of P-channel FET.

4. Based on the transistor configuration how amplifiers are classified.

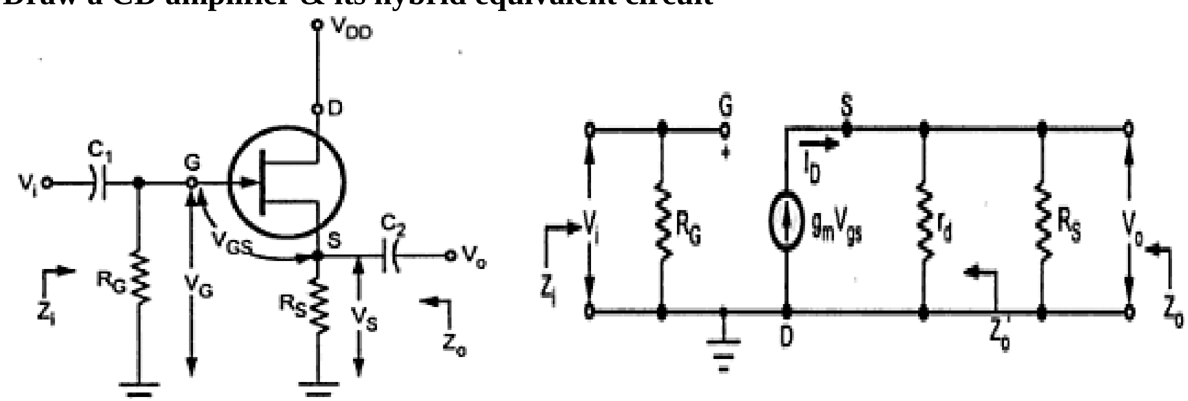
Based on transistor configuration, the amplifier are classified as

- Common Source amplifier
- Common gate amplifier
- Common Drain amplifier

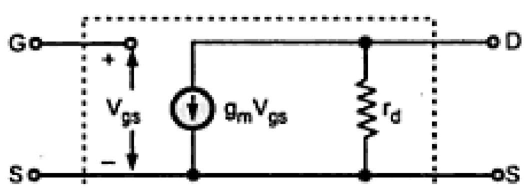
5. Draw a CS amplifier & its hybrid equivalent circuit.



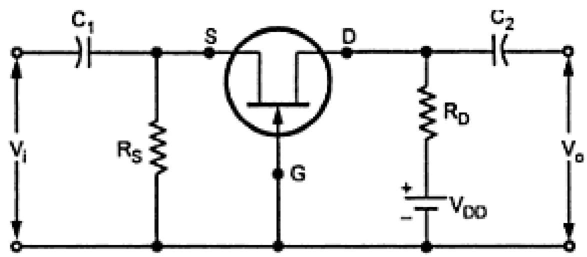
6. Draw a CD amplifier & its hybrid equivalent circuit

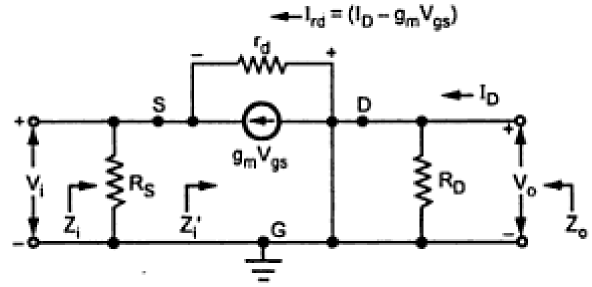


7. Give the JFET low frequency ac equivalent circuit for n- channel JFET

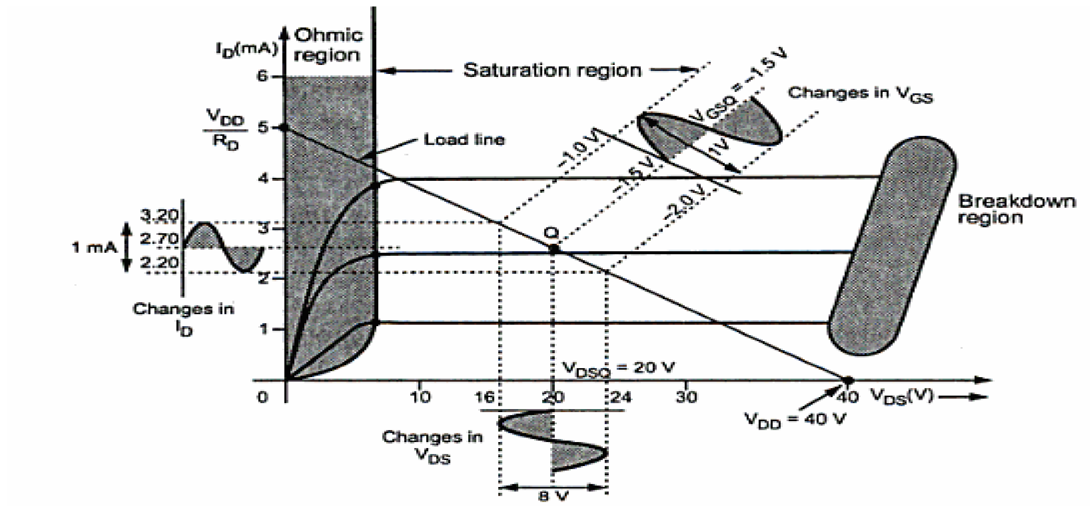


8. Draw a CG amplifier & its hybrid equivalent circuit





9. Draw the VI characteristics of JFET



10. What is transconductance factor.

The drain to source current of JFET is controlled by gate to source voltage. The change in the drain current due to change in gate to source voltage can be determined using the Trans conductance factor g_m

$$\Delta I_d = g_m \Delta V_{gs}$$

11. Give Zi, Z0, Av for Common Source amplifier with fixed bias.

Parameter	Exact	With $r_d >> R_D$
Z_i	R_G	R_G
Z_o	$R_D \| r_d$	R_D
A_v	$-g_m(R_D \| r_d)$	$-g_m R_D$

12. Give Zi, Z0, Av for Common Source amplifier with self bias (Bypassed Rs).

Parameter	Bypassed R_S	
	Exact	$r_d >> R_D$
Z_i	R_G	R_G
Z_o	$R_D \| r_d$	R_D
A_v	$-g_m(R_D \| r_d)$	$-g_m R_D$

13. Give Zi, Z0, Av for Common Source amplifier with self bias (Un-bypassed Rs).

Parameter	Unbypassed R_S	
	Exact	$r_d >> R_D$
Z_i	R_G	R_G
Z_o	$+ R_S(g_m r_d+1)] \parallel R_D$ or $+ R_S (\mu + 1)] \parallel R_D$	$[r_d + R_S \cdot (g_m r_d + 1)] \parallel R_D$ or $[r_d + R_S (\mu + 1)] \parallel R_D$
A_v	$\frac{-g_m R_D}{+g_m R_S + \frac{R_S + R_D}{r_d}}$	$\frac{-g_m R_D}{1 + g_m R_S}$

14. Give Zi, Z0, Av for Common Source amplifier with Voltage divider bias (Bypassed Rs).

	Bypassed R_S	
	Exact	$r_d >> R_D$
Z_i	$R_1 \parallel R_2$	$R_1 \parallel R_2$
Z_o	$r_d \parallel R_D$	R_D
A_v	$-g_m (r_d \parallel R_D)$	$-g_m R_D$

15. Give Zi, Z0, Av for Common Source amplifier with Voltage divider bias (Un-bypassed Rs).

	Unbypassed R_S	
	Exact	$r_d >> R_D$
Z_i	$R_1 \parallel R_2$	$R_1 \parallel R_2$
Z_o	$[r_d + g_m R_S r_d + R_S] \parallel R_D$ or $[r_d + R_s (\mu + 1)] \parallel R_D$	$[r_d + g_m R_s r_d + R_s)] \parallel R_D$ or $[r_d + R_s (\mu + 1)] \parallel R_D$
A_v	$\frac{-g_m R_D}{1 + g_m R_s + \frac{R_s + R_D}{r_d}}$	$\frac{-g_m R_D}{1 + g_m R_s}$

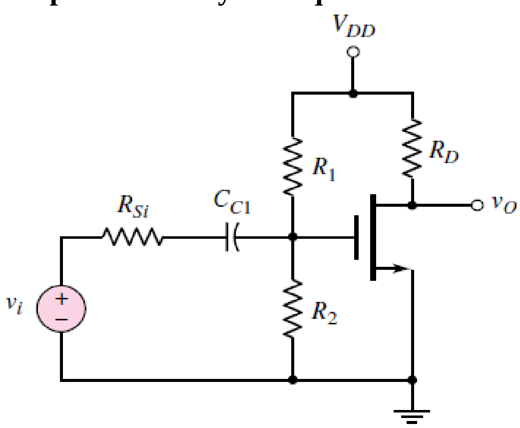
16. Give Zi, Z0, Av for Common Drain amplifier.

	Exact	$r_d >> R_D$
Z_i	R_G	R_G
Z_o	$\frac{1}{g_m} \parallel R_s$	$\frac{1}{g_m} \parallel R_s$
A_v	$\frac{g_m (r_d \parallel R_s)}{1 + g_m (r_d \parallel R_s)}$	$\frac{g_m R_s}{1 + g_m R_s}$

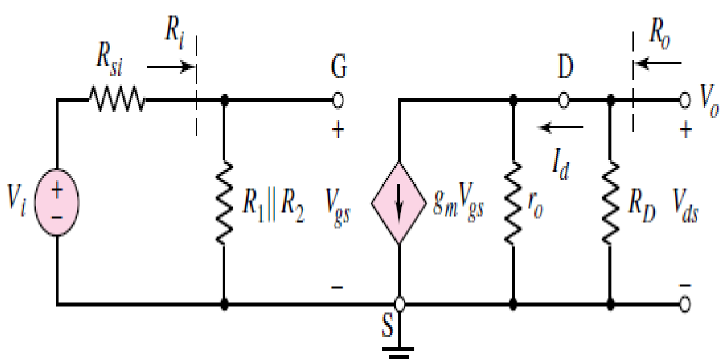
17. Give Zi, Z0, Av for Common Gate amplifier.

	Exact	$r_d >> R_D$
Z_i	$R_s \parallel \left[\frac{r_d + R_D}{1+g_m r_d}\right]$	$R_s \parallel \frac{1}{g_m}$
Z_o	$r_d \parallel R_D$	R_D
A_v	$\frac{R_D(1+g_m r_d)}{r_d + R_D}$	$g_m R_D$

18. Draw a CS amplifier & its hybrid equivalent circuit of



MOSFET.



19. Give Av for common source circuit with voltage divider bias and coupling capacitor.

$$A_v = \frac{V_o}{V_i} = -g_m(r_o \| R_D) \cdot \left(\frac{R_i}{R_i + R_{Si}}\right)$$

20. Write the advantages of BIMOS cascade amplifier.

A BIMOS amplifier combines the best feature of BJT and MOSFET amplifiers. This circuit has the advantages of the infinite input resistance of M1. The frequency response of a BIMOS cascade circuit is superior to that of an all MOSFET cascade circuit because the equivalent resistance looking into the emitter of a bipolar transistor is much less than the resistance looking into the source of a MOSFET.

PART-B

1. Draw a small signal low frequency model for an FET and explain.
2. Derive the expression for Zi, Z0, Av of Common Source amplifier with fixed bias
3. Derive the expression for Zi, Z0, Av of Common Source amplifier with self bias (Bypassed Rs).
4. Derive the expression for Zi, Z0, Av of Common Source amplifier with self bias (Un bypassed Rs).
5. Derive the expression for Zi, Z0, Av of Common Source amplifier with Voltage divider bias (Bypassed Rs).
6. Derive the expression for Zi, Z0, Av of Common Source amplifier with Voltage divider bias (Un bypassed Rs).
7. Derive the expression for Zi, Z0, Av of Common Drain amplifier.
8. Derive the expression for Zi, Z0, Av of Common Gate amplifier.
9. Derive the parameters of common source MOSFET amplifier
10. Derive the parameters of common Drain MOSFET amplifier
11. Derive the parameters of common gate MOSFET amplifier
12. Discuss about BIMOS cascade amplifier.

UNIT IV FREQUENCY RESPONSE OF AMPLIFIERS

PART A

1. **Define the frequency response of Amplifier.**

   The frequency response of an amplifier can be defined as the variation of output of quantity with respect to input signal frequency. In otherwise it can be defined as a graph drawn between the input frequency and the gain of an amplifier.

2. **Define lower & upper cut off frequencies of an amplifier.**

   Lower cut-off frequency

   The frequency (on lower side) at which the voltage gain of the amplifier is exactly 70.0% of the maximum gain is known as lower cut off frequency.

   Upper cut-off frequency

   The frequency (on higher side) at which the voltage gain of the amplifier is exactly 70.0% of the maximum gain is known as upper cut off frequency.

3. **Define bandwidth?**

   The range of frequencies occupied by the signal is known as its bandwidth.

4. **State the reason for fall in gain at low frequencies.**

   The coupling capacitance has very high reactance at low frequency. Therefore it will allow only a small part of signal from one stage to next stage and in addition to that the bypass capacitor cannot bypass or shunt the emitter resistor effectively. As a result of these factors, the voltage gain rolls of at low frequency.

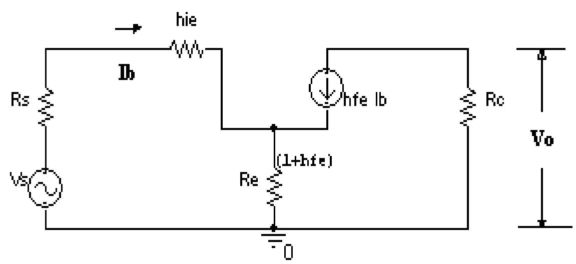
5. **State the reason for fall in gain at higher frequencies.**

   At high frequency the reactance of coupling capacitor is very low. Therefore it behaves like a short circuit. As a result of this the loading effect of the next stage increase which reduces the voltage gain. Hence the voltage gain rolls off at high frequencies.

6. **Why the electrolytic capacitor is not used for coupling?**
   Electrolytic capacitor is a polarized capacitor. So it cannot be used for coupling and also in electrolytic capacitor, the dielectric is not an insulating material but it conducting material which will change the capacitance effect.

7. **Write a note on effects of coupling capacitor.**
   The coupling capacitor Co transmits AC Signal but blocks DC. This prevents DC interferences between various stages and the shifting of operating point. It prevents the loading effect between adjacent stages.

8. **Draw the low frequency simplified h-parameter model of an amplifier with a unbypassed emitter resistor.**



9. **Why an NPN transistor has a better high frequency response than the PNP transistor?**
   An NPN transistor has a better frequency response than the PNP transistor because the mobility of electron is more and capacitive effect is less.
10. **Write an expression for the bandwidth of multistage amplifier.**
   The bandwidth of multistage amplifier is
   1. $f_2 - f_1 = f_o\sqrt{(2^{1/n}-1)}$

11. **What is the significance of gain bandwidth product?**
   It is very helpful in the preliminary design of a multistage wideband amplifier. This can be used to setup a tentative circuit, which is often used for this purpose.

12. **Why is the gain bandwidth product a constant?**
   It is defined as the magnitudes of the product of the mid band gain which is a constant and the bandwidth, which is also a constant. Hence the product of two constants should also be a constant.

13. **Define f_T and f .**
   Unity gain frequency (f_T) or frequency parameter.
   It is defined as the frequency at which the common emitter shirt circuit current gain has dropped to unity and is denoted by the symbol (f_T)
   Beta cut-off frequency (f_β)
   It is defined as the high frequency at which β-of a CE transistor drops to 0.707 or 3dB from its lower frequencies

14. **What is the need for having a high value of FET?**
   Bandwidth of the amplifier is directly proportional to FET. Hence to have larger bandwidth, the value of FET should be high.

15. **What is a cascade amplifier?**

The cascade configuration is an amplifier stage composed of a direct coupled common emitter / common base combination. This offers the possibility of a very large bandwidth.

16. Write the relation between the bandwidth and rise time of an amplifiers?

$BW=f_H = 0.35/t_r$

17. Write the overall lower cut off frequency of multistage amplifier?

$f_L(n) = f_L / (\sqrt{(2^{1/n}-1)})$

Where $f_L(n)$ – lower 3 dB frequency of identical cascaded stages

n - Number of stages

18. Write the overall higher cut off frequency of multistage amplifier?

$F_H(n) = f_H (\sqrt{(2^{1/n}-1)})$

Where $f_H(n)$ – lower 3 dB frequency of identical cascaded stages

n - Number of stages

19. Write the relation between the sag and lower cut-off frequency.

The tilt of sag in time t1 is given by

$f_L = p_f / 100$

p= Y of tilt

f= input signal frequency

$f_H = 2.2 / (2t_r) = 0.35/t_r$

20. For an amplifier, midband gain is 100 and lower cut off frequency is 1kHz. Find the gain of an amplifier at the frequency of 20Hz.

$A = (A_{mid})/((1+(f_1/f_2)2))$

$A = (100)/((1+(1000/20)2)) = 2$

21. What is dominant network?

In high frequency analysis of an amplifier, the network having lower critical frequency is called dominant network.

22. What is the function of Miller input capacitance of an amplifier?

The Miller input capacitance of an amplifier is a function of Bypass capacitor.

23. What are the advantages of representation of gain in decibels?

In multistage amplifier, it permits to add individual gains of the stages to calculate overall gain.

It allows us to denote, both very small as well as very large quantities of linear scale by considerably small figures.

24. What is the coupling methods used for coupling in multistage amplifiers?

The coupling methods used are,

RC coupling

Transformer coupling

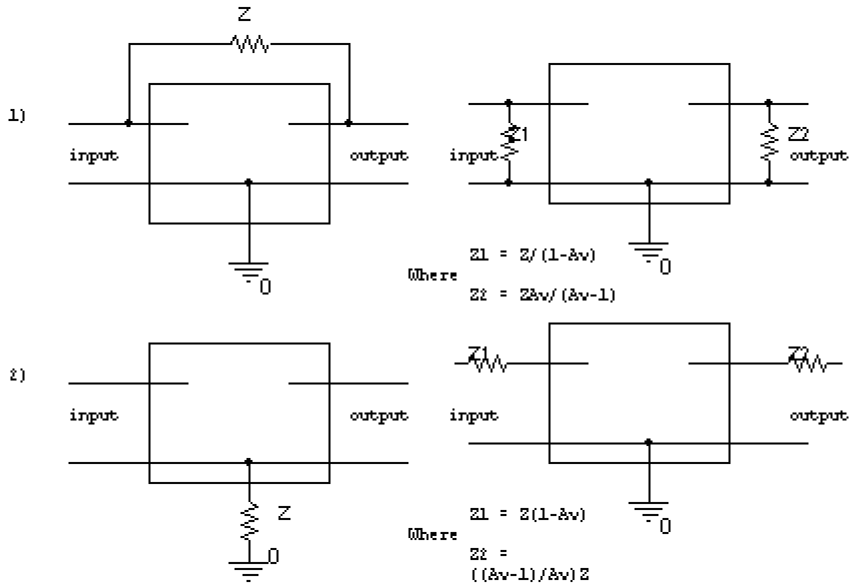
Direct coupling

25. Define Miller effect in input capacitance?

For any inverting amplifier, the input capacitance will be increased by a miller effect capacitance, sensitive to the gain of the amplifier and the inter electrode capacitance connected between the input and output terminals of the active device.

$C_{Mi} = (1-A_v)C_f$; $C_{Mo}=C_f$
C_f = Inter electrode capacitance between input and output.

26. Explain Miller's theorem.



27. What are the limitations of h parameters?

The h parameters has the following limitations,

The accurate calculation of h parameters is difficult.

A transistor behaves as a two port network for small signals only, hence h-parameters can be used to analyze only the small signal amplifiers.

28. Define dynamic range of an amplifier.

Dynamic range of an amplifier is defined as the range over which an active electronic device can produce a suitable output signal in response to an input signal.

29. What is meant by unity gain frequency?

The frequency at which the gain approaches unity is known as unity gain frequency.

PART B

1. Draw the high frequency equivalent circuit for a FET amplifier and derive the values of all the parameters.
2. Derive the expression for transistor conductance for hybrid Common emitter transistor model.
3. What is the effect of Cbe' on the input circuit of a BJT amplifier at high frequencies.
4. Find the equivalent miller capacitance if the Cbc' is 10pf, CB current gain is 0.99, the small signal resistance is 26 ohms and the load resistor is 10 k ohm.
5. How does base compensation help in broadcasting the bandwidth of an amplifier? Explain with necessary expressions.
6. Derive the expression for Ai, Av, Zi, Yo, Ap for transistor amplifier using h parameter model.
7. Derive the expression for CE short circuit current gain of a transistor at high frequency.
8. Define alpha and beta cutoff frequency, rise time, bandwidth and transition frequency and

derive their values interms of circuit parameters.

9. Discuss the frequency response characteristics of CE amplifier. Derive the general expression for gain at low, middle, high frequencies. Draw the bode plots for low and high frequencies.
10. Explain in detail about low frequency response of BJT amplifier.
11. Explain in detail about low frequency response of JFET amplifier.
12. Explain in detail about high frequency response of BJT amplifier.
13. Explain in detail about high frequency response of JFET amplifier.

UNIT VPOWER SUPPLIES AND ELECTRONIC DEVICE TESTING

PART A TWO MARKS QUESTIONS AND ANSWERS

1. What is a voltage regulator?

A voltage regulator is an electronic circuit that provides a stable dc voltage independent of the load current, temperature, and ac line voltage variations.

2. Give the classification of voltage regulators:

- Series / Linear regulators
- Switching regulators.

3. What is a linear voltage regulator?

Series or linear regulator uses a power transistor connected in series between the unregulated dc input and the load and it conducts in the linear region .The output voltage is controlled by the continuous voltage drop taking place across the series pass transistor.

4. What is a switching regulator?

Switching regulators are those which operate the power transistor as a high frequency on/off switch, so that the power transistor does not conduct current continuously. This gives improved efficiency over series regulators.\

5. Define line regulation.
Line regulation is defined as the percentage change in the output voltage for a change in the input voltage. It is expressed in mill volts or as a percentage of the output voltage.

6. Define load regulation.
Load regulation is defined as the change in output voltage for a change in load current. It is expressed in mill volts or as a percentage of the output voltage.

7. What is meant by current limiting?
Current limiting refers to the ability of a regulator to prevent the load current from increasing above a preset value.

8. Give the drawbacks of linear regulators:

- The input step down transformer is bulky and expensive because of low line frequency.
- Because of low line frequency, large values of filter capacitors are required to decrease the ripple.

- Efficiency is reduced due to the continuous power dissipation by the transistor as it operates in the linear region.

9. What is the advantage of switching regulators?
*Greater efficiency is achieved as the power transistor is made to operate as low impedance switch. Power transmitted across the transistor is in discrete pulses rather than as a steady current flow.
*By using suitable switching loss reduction technique, the switching frequency can be increased so as to reduce the size and weight of the inductors and capacitors.

10. What is a rectifier?
A rectifier is a device which converts alternating current (or voltage) into unidirectional current (or voltage).

11. What is the importance of peak inverse voltage?
If the applied voltage in reverse biased condition exceeds peak inverse voltage (PIV) rating of the diode, then the diode may get damaged.

12. Why half-wave rectifiers are generally not used in dc power supply?
The type of supply available from half-wave rectifier is not satisfactory for general power supply. That is why it is generally not used in dc power supply.

13. Why diodes are not operated in the breakdown region in rectifiers?
In breakdown region, a diode has a risk of getting damaged or burnt because the magnitude of current flowing through it increases in an uncontrollable manner. That is why diodes are not operated in the breakdown region in rectifiers.

14. Define ripple as referred to in a rectifier circuit.
The ac component contained in the pulsating output of a rectifier is known as ripple.

15. What is transformer utilization factor?
Transformer utilization factor is defined as the ratio of power delivered to the load and ac rating of secondary of supply power transformer.

16. Define rectifier. Mention the types.
Rectifier: A rectifier is a circuit that converts AC into pulsing DC. It uses unidirectional conducting devices like PN diodes.
Rectifiers are classified into two types based on the conduction of AC input.
They are:

- Half wave rectifier (HWR)
- Full wave rectifier (FWR).

17. Define rectifier efficiency.
It is defined as the ratio of DC power output to the applied AC power in put

18. Define ripple factor of a rectifier.

The purpose of a rectifier is to convert AC into DC. But the pulsating output of a rectifier contains a DC component and an AC component, called ripple. The ratio of RMS value of AC components to the DC component in the rectifier output is called ‘ripple factor’. The ripple factor is very important in deciding the effectiveness of a rectifier. It indicates the purity of the DC power output. The smaller the ripple factor, the lesser the effective AC component and hence more effective is the rectifier.

19. Define TUF of a rectifier.
Most of the rectifier circuits make use of transformer whose secondary feeds the AC power. The transformer rating is necessary to design a power supply. Transformer utilization factor (TF) id defined as the ratio of DC power delivered to the load to the AC power rating of transformer secondary.

20. Give the advantages and disadvantages of HWR and FWR.
Half Wave Rectifier (HWR)
Advantages

- Simple circuit
- Low cost

Disadvantages.

- Rectification efficiency is low (40.6%)
- .Very high amount of ripple ($\gamma = 1.21$)
- Low TUF (0.287)
- Saturation of transformer core occurs.

21. What is the need for a filter in rectifier?

The output of a rectifier is pulsating and contains a steady DC component with undesirable ripples. If such pulsating DC is given to the electronic circuits, it produces disturbances and other interferences. Hence ripples have to be kept far from the load

22. What is the need for voltage regulators? What are the drawbacks of unregulated power supply?

An ordinary (unregulated) power supply from the following drawbacks:

- Poor regulation

- The DC output voltage varies with the AC supply voltage which fluctuates at different times of the day and is different at different locations.

- The DC output voltage varies with temperature, in case semiconductors are used.

- For certain applications the output of the filter even with small amount of ripples is not acceptable

23. Define (i) Voltage regulation (ii) Minimum load resistance.
The variation of output voltage with respect to the amount of load current drawn from the power supply is called voltage regulation.
The change in DC output voltage from no load to full load with respect to full load voltage of a power supply is called its voltage regulation.

$$\text{\% voltage regulation} = \frac{V_{NL} - V_{FL}}{V_{FL}} X\ 100$$

Where ,
VNL = DC output voltage at no load
VFL = DC output voltage at full load

Smaller the percentage regulation better is the power supply. For a well-designed power supply, the percentage regulation should be less than 1%

24. What is the main difference between LPS and SMPS?

In the case of LPS, it has the voltage control element (transistor or zener diode), which dissipates the power equal to the voltage difference between an unregulated input voltage and a fixed output voltage multiplied by the current flowing through it. In the case of SMPS, the switching regulator acts as a variable power converter and also non-dissipative type regulator.

25.What are all the advantages of SMPS?

The advantages of SMPS are,
i. Efficiency is high because of less heat dissipation.
ii. As the transformer size is very small. It will have a compact unit.
iii. Isolation from main supply without the need of large main transformer.
iv. Very low ripple i.e., almost zero ripple factor, pure DC
output.
v. Better voltage regulation vi. Higher TUF.

26. What is SMPS?

SMPS stands for Switched Mode Power Supply. The SMPS does not use a transformer at the input, but operates directly from mains at a supply frequency of 50Hz. The AC main is directly rectified and filtered and the DC voltage so obtained is then used as an input to a switching type DC-to-DC converter.

27. Compare LMPS and SMPS.

LMPS
- The Control element is operated in active region
- It needs bulky components like transformer.
- It is operated in very low
- Frequency such as f=50Hz, hence heavy filtering is needed.

SMPS
- The control element is operated in cut off or
- Saturation region.
- It does not require transformer
- It is operated at high frequencies hence less
- Filtering is required.

PART B

1. Draw and explain the working principle of half wave rectifier.
2. Draw and explain the working principle of full wave rectifier.

3. With a neat diagram explain the operation of transistorized series feedback type regulator.
4. Discuss about electronically regulated dc power supplies.
5. Explain the circuit of voltage regulator and also discuss short circuit protection mechanism.
6. Explain the operation of SMPS with neat block diagram.
7. How will you design of a regulated dc power supply?
8. A diode has an internal resistance of 20 ohms from a 110 V rms source of supply. Calculate Efficiency of rectification, Ripple factor, The percentage of regulation. Assume HWR.
9. A full wave rectifier circuit is fed from a transformer. the rms voltage from either end of secondary is 20 V. if the diode forward resistance is 3 ohm and that of the half secondary is 5 ohms for a load of 1 K ohm Calculate Power delivered to load, % regulation ,Efficiency, TUF.

EC 8352-SIGNALS AND SYSTEMS

UNIT-I

CLASSIFICATION OF SIGNALS AND SYSTEMS

PART-A

1. Define Signal.

A signal is a function of one or more independent variables which contain some information.

Eg: Radio signal, TV signal, Telephone signal etc.

2. Define System.

A system is a set of elements or functional block that are connected together and produces an output in response to an input signal.

Eg: An audio amplifier, attenuator, TV set etc.

3. Define CT signals.

Continuous time signals are defined for all values of time. It is also called as an analog signal and is represented b y x (t).

Eg: AC waveform, ECG etc.

4. Define DT signal.

Discrete time signals are defined at discrete instances of time. It is represented by x(n).

Eg: Amount deposited in a bank per month.

5. Give few examples for CT signals.

AC waveform, ECG, Temperature recorded over an interval of time etc.

6. Give few examples of DT signals.

Amount deposited in a bank per month,

7. Define unit step, ramp and delta functions for CT.

Unit step function is defined as U(t)= 1 for t >= 0
0 otherwise

Unit ramp function is defined as r(t)=t for t>=0
0 for t<0

Unit delta function is defined as d(t)= 1 for t=0
0 otherwise

8. State the relation between step, ramp and delta functions(CT).

The relationship between unit step and unit delta function is d(t)= u(t)
The relationship between delta and unit ramp function is d(t).dt = r(t)

9. State the classification of CT signals.

The CT signals are classified as follows

(i) Periodic and non periodic signals
(ii) Even and odd signals
(iii) Energy and power signals
(iv) Deterministic and random signals.

10. Define deterministic and random signals.

A deterministic signal is one which can be completely represented by Mathematical equation at any time. In a deterministic signal there is no uncertainty with respect to its value at any time.

Eg: x(t)=cos wt, x(n)=2 pft

A random signal is one which cannot be represented by any mathematical equation.

Eg: Noise generated in electronic components, transmission channels, cables etc.

11. Define power and energy signals.

The signal x(t) is said to be power signal, if and only if the normalized average power p is finite and non-zero. i.e. $0<p< 4$

A signal x(t) is said to be energy signal if and only if the total normalized energy is finite and non-zero. i.e. $0<E< 4$

12. Compare power and energy signals.

Sl. No.	Power Signal	Energy Signal
1	The normalized average power is finite and non-zero	Total normalized energy is finite and non- zero
2	Practical periodic signals are power signals	Non-periodic signals are energy signals

13.Define odd and even signal.

A DT signal x(n) is said to be an even signal if x(-n)=x(n) and an odd signal if x(-n)=-x(n).

A CT signal is x(t) is said to be an even signal if x(t)=x(-t) and an odd signal if x(-t)=-x(t).

14. Define periodic and Aperiodic signals.

A signal is said to be periodic signal if it repeats at equal intervals.
Aperiodic signals do not repeat at regular intervals.

A CT signal which satisfies the equation x(t)=x(t+T) is said 0 to be periodic and a DT signal which satisfies the equation x(n)=x(n+N)is said to be periodic.

15. State the classification or characteristics of CT and DT systems.

The DT and CT systems are according to their characteristics as follows

(i). Linear and Non-Linear systems
(ii). Time invariant and Time varying systems.
(iii). Causal and Non causal systems.
(iv). Stable and unstable systems.
(v). Static and dynamic systems.
(vi). Inverse systems.

16. Define linear and non-linear systems.

A system is said to be linear if superposition theorem applies to that system. If it does not satisfy the superposition theorem, then it is said to be a nonlinear system.

17. Define Causal and non-Causal systems.

A system is said to be a causal if its output at anytime depends upon present and past inputs only.

A system is said to be non-causal system if its output depends upon future inputs also.

18. Define time invariant and time varying systems.

A system is time invariant if the time shift in the input signal results in corresponding time shift in the output.

A system which does not satisfy the above condition is time variant system.

19. Define stable and unstable systems.

When the system produces bounded output for bounded input, then the system is called bounded input, bounded output stable.

A system which does not satisfy the above condition is called unstable system.

20. Define Static and Dynamic system.

A system is said to be static or memory less if its output depends upon the present input only.

The system is said to be dynamic with memory if its output depends upon the present and past input values.

21. What is superposition property?

If an input consists of the weighted sum of several signals, then the output is the superposition that is, the weighted sum of the responses of the system to each of those signals.

22. Define a causal system?

The causal system generates the output depending upon present &past inputs only. A causal system is non anticipatory.

23. Define invertible system?

A system is said to be invertible if the input is get from the output input. Otherwise the system is noninvertible system.

<u>PART-B</u>

1. Discuss the classification of DT and CT signals with examples.

- Deterministic and random signals
- Periodic and Aperiodic signals
- Energy and power signals

- Noise signals
- Physically Realisable & non-realisable signals.

2. Discuss the classification of DT and CT systems with examples.

- Linear and Non-Linear systems
- Time invariant and Time varying systems
- Causal and Non-causal systems
- Stable and unstable systems
- Static and dynamic systems
- Inverse systems

3. Problems on the properties & classifications of signals & systems

Find whether the following signals are periodic or not

a. x(t)=2cos(10t+1)-sin(4t-1)

b. x(t)=3cos4t+2sin pφ

4. Check whether the following system is

1. Static or dynamic
2. Linear or non-linear
3. Causal or non-causal
4. Time invariant or variant

y(n)=sgn[x(n]

UNIT II
ANALYSIS OF CONTINUOUS TIME SIGNALS
PART-A

1.Define CT signal

Continuous time signals are defined for all values of time. It is also called as an analog signal and is represented by x (t).

Eg: AC waveform, ECG etc.

2. Compare double sided and single sided spectrums.

The method of representing spectrums of positive as well as negative frequencies are called double sided spectrums.

The method of representing spectrums only in the positive frequencies is known as single sided spectrums.

3. Define Quadrature Fourier Series.

Consider x(t) be a periodic signal. The Fourier series can be written for this signal as follows

$$x(t)= a + n8=1.\ a_n \cos w_0 nt + .\ 8n=1\ b \sin w_0 nt$$

This is known as Quadrature Fou rier Series.

4.Define polar Fourier Series.

$$x(t)= D_0 + n8=1\ D_n \cos((2\ pnt / T) +$$

The above form of representing a signal is known as Polar Fourier series.

5.Define exponential Fourier series.

$$x(t)= 8n=1\ C_n\ e\ j2pnt / T0$$

The method of representing a signal by the above form is known as exponential fourier series.

6. State Dirichlets conditions.

(i).The function x(t) should be single valued within the interval T_0

(ii). The function x (t) should have atmost a finite number of discontinuities in the interval T_0

(iii). The function x(t) should have finite number of maxima and minima in the interval T_0

(iv). The function should have absolutely integrable.

7. State Parsevals power theorem.

Parsevals power theorem states that the total average power of a periodic signal x(t) is equal to the sum of the average powers of its phasor components.

8.Define Fourier Transform.

Let x(t) be the signal which is the function of time t. The fourier transform of x(t) is given by

$$X(w)= x(t)e^{-jwt}\, dt$$

9. State the conditions for the existence of Fourier series.

(i). The function x(t) should be single valued in any finite time interval T

(ii). The function x(t) should have atmost finite number of discontinuities in any finite time interval T.

(iii). The function x(t) should have finite number of maxima and minima in any time interval T.

(iv) The function x(t) should be absolutely integrable.

10. Find the Fourier transform of function x(t)= d**(t)**

Ans: 1

11. State Rayleigh's energy theorem.

Rayleigh's energy theorem states that the energy of the signal may be written in frequency domain as superposition of energies due to individual spectral frequencies of the signal.

12.Define Laplace transform.

Laplace transform is the another mathematical tool used for analysis of continuous time signals and systems. It is defined as

$$F(s) = f(t)\, e^{-st}\, dt$$

13. Obtain the Laplace transform of ramp function.

Ans: $1/s^2$

14. What are the methods for evaluating inverse Laplace transform?

The two methods for evaluating inverse Laplace transform are

(i). By Partial fraction expansion method.

(ii). By convolution integral.

15. State initial value theorem.

If x(t)-----L------ --- X(s), then value of x(t)is geven as,

$$x(0+) = \lim_{t\to0+} [\, sX(s)]$$

provided that the first derivative of x(t) should be Laplace transformable.

16. State final value theorem.

If x(t) and X(s) are Laplace transform pairs, then the final value of x(t) is given as ,

Lim t->4 x(t)= Lim s->0 [sX(s)]

17. State the convolution property of Fourier transform.

If x1(t) and x1(f) are Fourier transform pairs and x2(t) and x2(f) are Fourier transform pairs, then x1(t)x 2(f- t)d t is Fourier transform pair with X1(f)X2(f)

18. What is the relationship between Fourier transform and Laplace transform.

X(s)=X(jw) when s=jw

This states that laplace transform is same as fourier transform when s=jw.

19.Find the fourier transform of sgn function.

Ans: 2/j

20. Find out the laplace transform of f(t)=e^{at} ….

Ans: 1/(s-a)

21. What are the types of Fourier series?

i. Exponential Fourier series

ii. Trigonometric Fourier series

22. Write down the exponential form of the fourier series representation of aperiodic signal?

$x(t)= \sum a_k \cdot e^{jk\,\omega o t}$

Here the summation is taken from - ∞ to ∞.

$a_k = 1/T \int x(t) e^{-jk\,\omega o t}$

Here the integration is taken from 0 to T.

The set of coefficients { ak } are often called the fourier series co efficient or spectral coefficients. The coefficient a_o is the dc or constant component of x(t).

23. What is the use of Laplace transform?

Laplace transform is an another mathematical tool used for analysis of signals and systems. Laplace transform is used for analysis of unstable systems.

24. What are the types of Laplace transform?

i. Bilateral or two sided Laplace transform.

ii. Unilateral or single sided Laplace transform.

25. Define Bilateral and unilateral Laplace transform?

The bilateral laplace transform is defined as

$$X(s)= \int x(t) e^{-st} dt$$

Here the integration is taken from - ∞ to ∞. Hence it is called bilateral Laplace transform

The unilateral laplace transform is defined as

$$X(s)= \int x(t) e^{-st} dt$$

Here the integration is taken from 0 to ∞. Hence it is called unilateral Laplace transform.

26. Define inverse Laplace transform?

The inverse Laplace transform is given as

$x(t)=1/2\pi j\int X(s)\, e^{st} ds$

Here the integration is taken from $\sigma - j\infty$ to $\sigma + j\infty$.

PART-B

1.State and prove properties of fourier transform.

- Linearity property
- Shifting property
- Frequency shifting
- Differentiation in time domain
- Integration in time domain
- Convolution in time domain

2. State the properties of Fourier Series.

- Linearity property
- Shifting property
- Convolution in time domain
- Multiplication in time domain
- Duality property
- Parsevals theorem

3. State the properties of Laplace transform.

- Linearity property
- Shifting property
- Complex translation
- Differentiation in time domain
- Integration in time domain
- Initial value theorem
- Final value theorem
- Convolution in time domain

4. Problems on Fourier series, Fourier transform and Laplace transform.

5. State and prove parsevals power theorem and Rayleigh's energy theorem.

UNIT- III

LINEAR TIME INVARIANT – CONTINUOUS TIME SYSTEMS

PART-A

1. Define LTI-CT systems.

In a continuous time system if the time shift in the input signal results in the corresponding time shift in the output, then it is called the LTI-CT system

2. What are the tools used for analysis of LTI-CT systems?

The tools used for the analysis of the LTI-CT system are

- Fourier transform
- Laplace transform

3.Define convolution integral.

The convolution of of two signals is given by

$$y(t)= x(t)*h(t)$$

where

$$x(t)*h(t)= x(t)h(t- t).d$$

This is known as convolution integral.

4.List the properties of convolution integral.

a. commutative property
b. distributive property
c. associative property
d. shift property
e. convolution with an impulse
f. width property

5.State commutative property of convolution .

The commutative property of convolution states that

$$x1(t)*x2(t)=x\ 2(t)*x1(t)$$

6.State the associative property of convolution .

Associative property o f convolution states that

$$x1(t)*[x2(t)*x3(t)]=[x1(t)*x2(t)]\ *x\ 3$$

7.State distributive property of convolution .

The distributive property states that

$$x1(t)*[x2(t)+x\ 3(t)]=x1(t)*x2(t)+x1(t)*x3(t)$$

8 . When the LTI-CT system is said to be dynamic?

In LTI CT system, the system is said to be dynamic if the present output depends only on the present input.

9. When the LTI-CT system is said to be causal?

An LTI continuous time system is causal if and only if its impulse response is zero for negative values of t.

10. When the LTI-CT system is said to be stable?

A LTI-CT system is said to be stable if the impulse response of the system is absolutely integrable. That is

$$h(t) < 4$$

11. Define natural response.

Natural response is the response of the system with zero input. It depends on the initial state of the system. It is denoted by y n (t)

12. Define forced response.

Forced response is the response of the system due to input alone when the initial state of the system is zero. It is denoted by y f(t).

13. Define complete response.

The complete response of a LTI-CT system is obtained by adding the natural response and forced response.

$$y(t)= y\ n\ (t)+ y\ f\ (t)$$

14 . Draw the direct form I implementation of CT systems.

15. Draw the direct form II implementation of CT systems.

16. Mention the advantages of direct form II structure over direct form I structure.
No.of integrators are reduced to half
17. Define Eigen function and Eigen value.
In the equation given below,

$$y(t)=H(s)e^{st}$$

H(s) is called Eigen value and e^{st} is called Eigen function.
18. **Define Causality and stability using poles**.
For a system to be stable and causal, all the poles must be located in the left half of the s plane.
19. **Find the impulse response of the system y(t)=x(t-t 0) using Laplace transform** .
Ans:

$$h(s)= d\ (t-t_0)$$

20. The impulse response of the LTI CT system is given as h(t)=e -t u(t). Determine transfer function and check whether the system is causal and stable.
Ans:

$$H(s)=1/(s+1)$$

The system is causal, stable.
21. State the significance of block diagram representation.
The LTI systems are represented with the help of block diagrams. The block diagrams are more effective way of system description. Block Diagrams indicate how individual calculations are performed. Various blocks are used for block diagram representation.

PART-B

1. State and prove the properties of convolution sum?

- Commutative property of convolution x(n) * h(n) = h(n) * x(n)= y(n)
- Associative property of convolution [x(n) * h1(n)]* h2(n) = x (n) * [h1(n)*h2(n)]
- Distributive property of convolution X(n)*[h1(n) + h2(n)] = x(n) * h1(n) + x(n) * h2(n)

2. Determine the convolution of x(n) = {1,1,2} h(n)=u(n) graphically.
3. Determine the forced response for the following system y(n)-1 y(n-1) -1 y(n-2) = x(n)+ x(n-1) for x(n) =(1/8)n u(n), Assume zero initial conditions.
4. Compute the response of the system y(n) = 0.7 u(n-1) – 0.12 y(n-2) + x(n-2) to the input x(n) = n u(n). Is the system is stable?
5. Derive the 8 point DIT and DIF algorithms.

UNIT-IV
ANALYSIS OF DISCRETE TIME SIGNALS
PART-A

1. Define DTFT.

Let us consider the discrete time signal x(n).Its DTFT is denoted as X(w). It is given as $X(w)= x(n)e^{-jwn}$

2. State the condition for existence of DTFT?

The conditions are

- If x(n)is absolutely summable then
  |x (n) |<
- If x(n) is not absolutely summable then it should have finite energy for DTFT to exit.

3. List the properties of DTFT.

- Periodicity
- Linearity
- Time shift
- Frequency shift
- Scaling
- Differentiation in frequency domain
- Time reversal
- Convolution
- Multiplication in time domain
- Parseval's theorem

4. What is the DTFT of unit sample?

The DTFT of unit sample is 1 for all values of w.

5. Define DFT.

DFT is defined as $X(w)= x(n)e^{-jwn}$. Here x(n) is the discrete time sequence X(w) is the Fourier transform of x(n).

6. Define Twiddle factor.

The Twiddle factor is defined as $W N=e^{-j2 /N}$

7. Define Zero padding.

The method of appending zero in the given sequence is called as Zero padding.

8. Define circularly even sequence.

A Sequence is said to be circularly even if it is symmetric about the point zero on the circle.

$$x(N-n)=x(n),1<=n<=N-1.$$

9. Define circularly odd sequence.

A Sequence is said to be circularly odd if it is anti symmetric about point x(0) on the circle

10. Define circularly folded sequences.

A circularly folded sequence is represented as $x((-n))_N$. It is obtained by plotting x(n) in clockwise direction along the circle.

11. State circular convolution.

This property states that multiplication of two DFT is equal to circular convolution of their sequence in time domain.

12. State parseval's theorem.

Consider the complex valued sequences x(n) and y(n).If x(n) ---- X(k), y(n) ---- Y(k) then x(n)y*(n)=1/N X(k)Y*(k)

13. Define Z transform.

The Z transform of a discrete time signal x(n) is denoted by X(z) and is given by

$X(z)= x(n)Z^{-n}$.

14. Define ROC.

The value of Z for which the Z transform converged is called region of convergence.

15. Find Z transform of x(n)={1,2,3,4}

x(n)= {1,2,3,4}

$X(z)= x(n)z^{-n}$

$= 1+2z^{-1} +3z^{-2} +4z^{-3}$.

$= 1+2/z+3/z^{2}+4/z^{3}$.

16. State the convolution property of Z transform.

The convolution property states that the convolution of two sequences in time domain is equivalent to multiplication of their Z transforms.

17. What z transform of (n-m)?

By time shifting property

$Z[A (n-m)]=AZ^{-m}$ sinZ[(n)] =1

18. State initial value theorem.

If x(n) is causal sequence then its initial value is given by x(0)=lim X(z)

19. List the methods of obtaining inverse Z transform.

Inverse z transform can be obtained by using

- Partial fraction expansion.
- Contour integration
- Power series expansion
- Convolution.

20. Obtain the inverse z transform of X(z)=1/z-a,|z|>|a|

Given $X(z)=z^{-1} /1-a^{z\ -1}$

By time shifting property

$X(n)=a^{n}.u(n-1)$

21. What are the Properties of ROC.

i. The ROC of a finite duration sequence includes the entire z plane, except z= 0 and |z|=∞

ii. ROC does not contain any poles.

iii. ROC is the ring in the z-plane centered about origin.
iv. ROC of causal sequence (right handed sequence) is of the form |z| r.
v. ROC of left handed sequence is of the form |z| < r.
vi. ROC of two sided sequence is the concentric ring in the z plane.

22. State the methods to find inverse Z transform.

a. Partial fraction expansion
b. Contour integration
c. Power series expansion
d. Convolution method.

23. What is meant by sampling?

A sampling is a process by which a CT signal is converted into a sequence of discrete samples with each sample representing the amplitude of the signal at the particular instant of time.

24. State Sampling theorem?

A band limited signal of finite energy, which has no frequency components higher than the W hertz, is completely described by specifying the values of the signal at the instant of time separated by 1/2W seconds and A band limited signal of finite energy, which has no frequency components higher than the W hertz, is completely recovered from the knowledge of its samples taken at the rate of 2W samples per second.

25. What is meant by aliasing?

When the high frequency interferes with low frequency and appears as low then the phenomenon is called aliasing.

26. What are the effects aliasing?

Since the high frequency interferes with low frequency then the distortion is generated. The data is lost and it cannot be recovered.

27. How the aliasing process is eliminated,

i). Sampling rate $f_s \geq 2W$.
ii). Strictly band limit the signal to 'W'. This can be obtained by using the Low pass filer before the sampling process. It is also called as anti-aliasing filter.

28. Define Nyquist rate and Nyquist interval.

When the sampling rate becomes exactly equal to '2W'samples/sec, for a given bandwidth of W hertz, then it is called Nyquist rate.Nyquist interval is the time interval between any two adjacent samples.
Nyquist rate = 2W Hz
Nyquist interval = 1/2W seconds.

29. Define sampling of band pass signals.

A band pass signal x(t) whose maximum bandwidth is '2W' can be completely represented into and recovered from its samples, if it is sampled at the minimum rate of twice the band width.

PART-B

1. Derive the convolution integral and also state and prove the properties of the same.
2. Explain the properties of LTI CT system interms of impulse response.
3. Problems on properties of LTI CT systems.
4. Problems on differential equations.
5. Realization of LTI CT system using direct form I and II structures.
6. Finding frequency response using Fourier methods.

Steps:

- Take Fourier transform for the given differential equations.
- Find system transfer function H(w)
- The frequency response can be obtained from the transfer function by separating the real and imaginary parts.

7. Solving differential equations using Fourier methods.

Steps:

- Take Fourier transform for the given differential equation.
- Then find Y(s) using the given initial conditions.
- Then find y(t) by taking inverse Fourier transform.

8. Solving differential equations using Laplace methods.

Steps:

- Take Laplace transform for the given differential equation.
- Then find Y(s) using the given initial conditions.
- Then find y(t) by taking inverse Laplace transform.

9. Obtaining state variable description.

Steps:

- The state variable description consists of differential equations that describe state of the system.
- The output of the system is related to current state and input.
- The state is the minimal set of signals that represent systems entire pass memory.
- The state equations for LTI CT system can be written as $d/dt[q(t)] = A\ q(t) + b\ x(t)$, $y(t) = cq(t) + D\ x(t)$ hence A,b,c, D are the matrices representing internal structure of the system.

UNIT-V
LINEAR TIME INVARIANT DISCRETE TIME SYSTEMS
PART-A

1. Define convolution sum?

If x(n) and h(n) are discrete variable functions, then its convolution sum y(n) is given by,

$$y(n)= x(k)\ h(n-k)$$

2. List the steps involved in finding convolution sum?

- Folding
- Shifting
- Multiplication
- Summation

3.List the properties of convolution?

- Commutative property of convolution

$$x(n) * h(n) = h(n) *x(n) = y(n)$$

- Associative property o f convolution

$$[\ x(n) * h_1(n)] * h_2(n) = x(n) * [h_1(n) *h_2(n)]$$

- Distributive property of convolution

$$x(n) * [h_1(n) + h_2(n)] = x (n) * h_1(n) + x(n) * h_2(n)$$

4. Define LTI causal system?

A LTI system is causal if and only if ,h(n) = 0 for n<0.This is the sufficient and necessary condition for causality of the system.

5. Define LTI stable system?

The bounded input x(n) produces bounded output y(n) in the LTI system only if, | h(k)| <8. When this condition is satisfied, the system will be stable.

6. Define FIR system?

The systems for which unit step response h(n) has finite number of terms, they are called Finite Impulse Response (FIR) systems.

7. Define IIR system?

The systems for which unit step response h(n) has infinite number of terms, they are called Infinite Impulse Response (IIR) systems.

8. Define non recursive and recursive systems?

When the output y(n) of the system depends upon present and past inputs then it is called non-recursive system.

When the output y(n) of the system depends upon present and past inputs as well as past outputs, then it is called recursive system.

9. State the relation between Fourier transform and z transform?

The Fourier transform is basically the z-transform of the sequence evaluated on unit circle.
i.e., $X(z)|\ z=e^{j} = X(\ )$ at $|z|=1$ i.e., unit circle.

10. Define system function?

$H(z)= Y(z)$ is called system function.It is the z transform of the unit Sample $X(Z)$ response $h(n)$ of the system.

11. What is the advantage of direct form 2 over direct form 1 structure?

The direct form 2 structure has reduced memory requirement compared to direct form 1 structure.

12. List the applications of FFT?

- Filtering
- Spectrum analysis
- Calculation of energy spectral density

15. How unit sample response of discrete time system is defined?

The unit step response of the discrete time system is output of the system to
Unit sample sequence. i.e., T[ð(n)]=h(n). Also h(n)=z {H(z)}.

16.A causal DT system is BIBO stable only if its transfer function has __________.

Ans:A causal DT system is stable if poles of its transfer function lie within
The unit circle

17. If u(n) is the impulse response response of the system, What is its step response?

Here $h(n) = u(n)$ and the input is $x(n) = u(n)$.
Hence the output $y(n) = h(n) * x(n)$
$= u(n) * u(n)$

18.Convolve the two sequences x(n)={1,2,3} and h(n)={5,4,6,2}

Ans: y(n)={5,14,29,26,22,6}

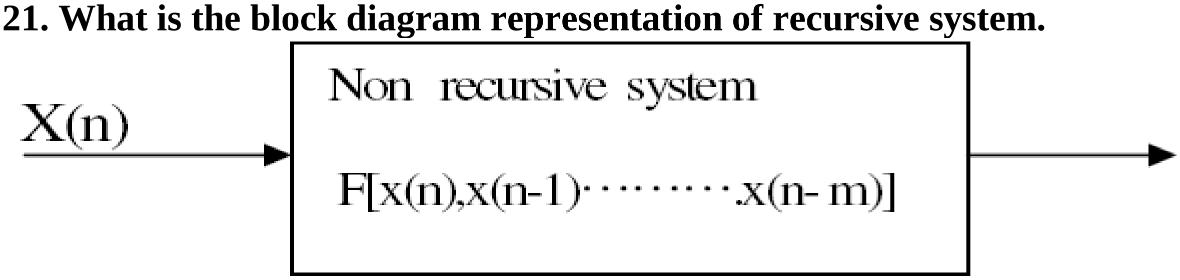
19. State the maximum memory requirement of N point DFT including twiddle factors?

Ans: [2N+N/2]

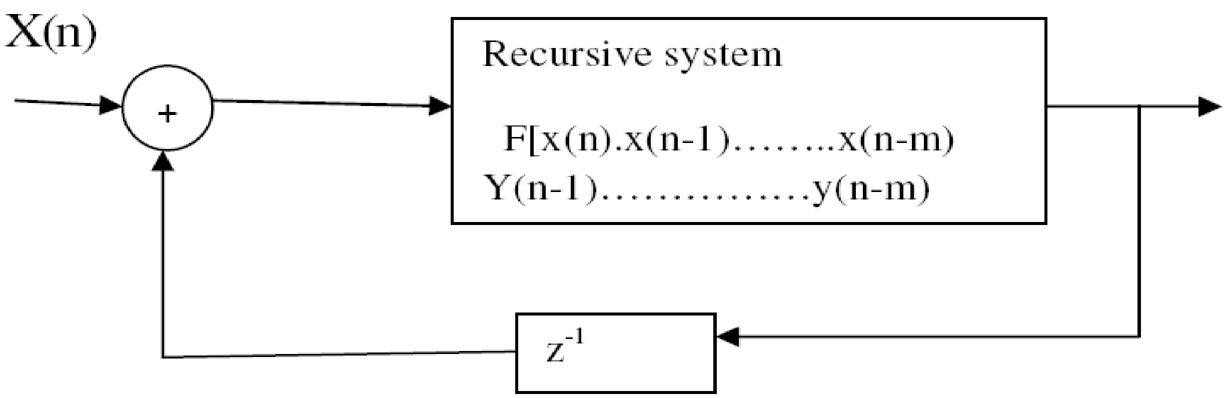
20.Determine the range of values of the parameter 'a' for which the linear time invariant system with impulse response $h(n)=a^{n}u(n)$ is stable?

Ans: H(z)= z , There is one pole at z=a. The system is stable, if all its poles. z-a i.e., within the unit circle. Hence $|a| < 1$ for stability.

21. What is the block diagram representation of recursive system.



22. What is the block diagram representation of non recursive system.



23. What is the difference between recursive and non recursive system Non recursive system?

A recursive system have the feedback and the non recursive system have no feedback.

And also the need of memory requirement for the recursive system is less than non recursive system.

24. Define realization structure.

The block diagram representation of a difference equation is called realization structure. These diagram indicate the manner in which the computations are performed.

25. What are the different types of structure realization.

i. Direct form I
ii. Direct form II
iii. Cascade form
iv. Parallel Form.

<u>**PART-B**</u>

1. State and prove properties of DTFT

- Periodicity
- Linearity
- Time shift
- Frequency shift
- Scaling
- Differentiation in frequency domain
- Time reversal
- Convolution
- Multiplication in time domain
- Parseval's theorem.

2. State and prove the properties of DFT.

- Periodicity
- Linearity

• Circular symmetries of a sequence
• Symmetry properties
• Circular convolution
• Time reversal of a sequence
• Circular time shift of a sequence
• Circular frequency shift
• Complex conjugate properties
• Circular correlation
•Multiplication of two sequences
• Parsevals theorem

3. State and prove the properties of z transform.

- Linearity
- Time shifting
- Scaling in z domain
- Time reversal
- Differentiation in z domain
- Convolution in time domain
- Correlation of two sequences
- Multiplication of two sequences
- Conjugation of a complex sequence
- Z transform of real part of the sequence
- Z transform of imaginary part of the sequence
- Parsevals relation
- Initial value theorem

4. Find the DFT of x(n)={1,1,1,1,1,1,0,0}

5. Find the circular convolution of x 1 (n)={1,2,0,1} X 2 (n)={2,2,1,1}

6. Problems on z transform and inverse z transform.

EC 8392-Digital Electronics

PART – A (2 MARKS)

UNIT – I

DIGITAL FUNDAMENTALS

1) Define binary logic?

Binary logic consists of binary variables and logical operations. The variables are designated by the alphabets such as A, B, C, x, y, z, etc., with each variable having only two distinct values: 1 and 0. There are three basic logic operations: AND, OR, and NOT.

2) Convert (634) 8 to binary

6 3 4

110 011 100

Ans = 110011100

3) Convert (9B2 - 1A) H to its decimal equivalent.

$N = 9 \times 16^{2} + B \times 16^{1} + 2 \times 16^{0} + 1 \times 16^{-1} + A (10) \times 16^{-2}$

= 2304 + 176 + 2 + 0.0625 + 0.039

= **2482.1_{10}**

4) State the different classification of binary codes?

1. Weighted codes
2. Non - weighted codes
3. Reflective codes
4. Sequential codes
5. Alphanumeric codes
6. Error Detecting and correcting codes.

5) Convert 0.640625 decimal numbers to its octal equivalent.

0.640625 x 8 = 5.125

0.125 x 8 = 1.0

= 0.640 625 10 = **(0.51) 8**

6) Convert 0.1289062 decimal numbers to its hex equivalent

0.1289062 x 16 = 2.0625

0.0625 x 16 = 1.0

= **0.21_{16}**

7) Convert 22.64 to hexadecimal number.

22/16 -1-6

0.64 x 16 = 10.24

0.24 x 16 = 3.84

0.84 x 16 = 13.44

.44 x 16 = 7.04

Ans = (16. A 3 D 7)

8) State the steps involved in Gray to binary conversion?

The MSB of the binary number is the same as the MSB of the gray code number. So write it down. To obtain the next binary digit, perform an exclusive OR operation between the bit just written down and the next gray code bit. Write down the result.

9) Convert gray code 101011 into its binary equivalent.

Gray Code: 1 0 1 0 1 1

Binary Code: **1 1 0 0 1 0**

10) Substract (0 1 0 1) 2 from (1 0 1 1) 2

1 0 1 0

0 1 0 1

Answer = 0 1 1 0

11) Add (1 0 1 0) 2 and (0 0 1 1) 2

1 0 1 0

0 0 1 1

Answer = (1 1 0 1) 2

12) Using 10's complement subtract 72532 - 3250

M = 72532

10's complement of N = + 96750

Sum = 169282

iscard end carry

Answer = 69282

13) Find 2'S complement of (1 0 1 0 0 0 1 1) 2

0 1 0 1 1 1 0 0 1 - 1's Complement

\+ 1

0 1 0 1 1 1 0 1 0 - 2's complement.

14) Substract 1 1 1 0 0 1 2 from 1 0 1 0 1 1 2 using 2's complement method

1 0 1 0 1 1

\+ 0 0 0 1 1 1 - 2's comp. of 1 1 1 0 0 1

1 1 0 0 1 0 in 2's complement form

Answer (0 0 1 1 1 0)2

15) Find the excess -3 code and 9's complement of the number 403_{10}

4 0 3

0 1 0 0 0 0 0 0 0 0 1 1

0 0 1 1 0 0 1 1 0 0 1 1 +

0 1 1 1 0 0 1 1 0 1 1 0 ----- excess 3 code

9's complement 1 0 0 0 1 1 0 0 1 0 0 1

16) What is meant by bit?

A binary digit is called bit

17) Define byte?

Group of 8 bits.

18) List the different number systems?

i) Decimal Number system ii)

Binary Number system iii)

Octal Number system

iv) Hexadecimal Number system

19) State the abbreviations of ASCII and EBCDIC code?

ASCII-American Standard Code for Information Interchange.

EBCDIC-Extended Binary Coded Decimal Information Code.

20) What are the different types of number complements?

i) r's Complement

ii) (r-1)'s Complement.

1) Given the two binary numbers X = 1010100 and Y = 1000011, perform the subtraction (a) X -Y and (b) Y - X using 2's complements. a)

X = 1010100

2's complement of Y = 0111101

Sum = 10010001

Discard end carry

***Answer:* X - Y = 0010001**

b) Y = 1000011

2's complement of X = + 0101100

Sum = 1101111

There is no end carry, The MSB BIT IS 1.

Answer is Y-X = -(2's complement of 1101111) = - 0010001

22) Given the two binary numbers X = 1010100 and Y = 1000011, perform the subtraction (a) X -Y and (b) Y - X using 1's complements. a)

X - Y = 1010100 - 1000011

X = 1010100

1's complement of Y = + 0111100

Sum = 10010000

End -around carry = + 1

***Answer:* X - Y = 0010001**

b) Y - X = 1000011 - 1010100

Y = 1000011

1's complement of X = + 0101011

Sum = + 1101110

There is no end carry.

Therefore the answer is Y - X = -(1's complement of 1101110) = -0010001

23) Write the names of basic logical operators.

1. NOT / INVERT
2. AND
3. OR

24) What are basic properties of Boolean algebra?

The basic properties of Boolean algebra are commutative property, associative property and distributive property.

25) State the associative property of boolean algebra.

The associative property of Boolean algebra states that the OR ing of several variables results in the same regardless of the grouping of the variables. The associative property is stated as follows:

A+ (B+C) = (A+B) +C

26) State the commutative property of Boolean algebra.

The commutative property states that the order in which the variables are OR ed makes no difference. The commutative property is:

A+B=B+A

27) State the distributive property of Boolean algebra.

The distributive property states that AND ing several variables and OR ing the result with a single variable is equivalent to OR ing the single variable with each of the the several variables and then AND ing the sums. The distributive property is:

A+BC= (A+B) (A+C)

28) State the absorption law of Boolean algebra.

The absorption law of Boolean algebra is given by X+XY=X, X(X+Y) =X.

29) Simplify the following using De Morgan's theorem [((AB)'C)'' D]'

[((AB)'C)'' D]' = ((AB)'C)'' + D' [(AB)' = A' + B']

= (AB)' C + D'

= (A' + B')C + D'

30) State De Morgan's theorem.

De Morgan suggested two theorems that form important part of Boolean algebra. They are,

1) The complement of a product is equal to the sum of the complements.

(AB)' = A' + B'

2) The complement of a sum term is equal to the product of the complements. (A + B)' = A'B'

31) Reduce A.A'C

A.A'C = 0.C [A.A' = 1]

= 0

31) Reduce A(A + B)

A(A + B) = AA + AB

= A(1 + B) [1 + B = 1]

= A.

32) Reduce A'B'C' + A'BC' + A'BC

A'B'C' + A'BC' + A'BC = A'C'(B' + B) + A'B'C

= A'C' + A'BC [A + A' = 1]

= A'(C' + BC)

= A'(C' + B) [A + A'B = A + B]

33) Reduce AB + (AC)' + AB'C(AB + C)

AB + (AC)' + AB'C(AB + C) = AB + (AC)' + AAB'BC + AB'CC

= AB + (AC)' + AB'CC [A.A' = 0]

= AB + (AC)' + AB'C [A.A = 1]

= AB + A' + C' =AB'C [(AB)' = A' + B']

= A' + B + C' + AB'C [A + AB' = A + B]

= A' + B'C + B + C' [A + A'B = A + B]

= A' + B + C' + B'C

=A' + B + C' + B'

=A' + C' + 1

= 1 [A + 1 =1]

34) Simplify the following expression Y = (A + B)(A + C')(B' + C') Y =

(A + B)(A + C')(B' + C')

= (AA' + AC +A'B +BC)(B' + C') [A.A' = 0]

= (AC + A'B + BC)(B' + C')

= AB'C + ACC' + A'BB' + A'BC' + BB'C + BCC'

= AB'C + A'BC'

35) Show that (X + Y' + XY)(X + Y')(X'Y) = 0

(X + Y' + XY)(X + Y')(X'Y) = (X + Y' + X)(X + Y')(X' + Y) [A + A'B = A + B]

= (X + Y')(X + Y')(X'Y) [A + A = 1]

= (X + Y')(X'Y) [A.A = 1]= X.X' + Y'.X'.Y

= 0 [A.A' = 0]

36) Prove that ABC + ABC' + AB'C + A'BC = AB + AC + BC

ABC + ABC' + AB'C + A'BC=AB(C + C') + AB'C + A'BC

=AB + AB'C + A'BC

=A(B + B'C) + A'BC

=A(B + C) + A'BC

=AB + AC + A'BC

=B(A + C) + AC

=AB + BC + AC

=AB + AC +BC ...Proved

37) Convert the given expression in canonical SOP form Y = AC + AB + BC

Y = AC + AB + BC

=AC(B + B') + AB(C + C') + (A + A')BC

=ABC + ABC' + AB'C + AB'C' + ABC + ABC' + ABC

=ABC + ABC' +AB'C + AB'C' [A + A =1]

38) Define duality property.

Duality property states that every algebraic expression deducible from the postulates of Boolean algebra remains valid if the operators and identity elements are interchanged. If the dual of an algebraic expression is desired, we simply interchange OR and AND operators and replace 1's by 0's and 0's by 1's.

39) Find the complement of the functions F1 = x'yz' + x'y'z and F2 = x(y'z' + yz). By applying De-Morgan's theorem.

$F1' = (x'yz' + x'y'z)' = (x'yz')'(x'y'z)' = (x + y' + z)(x + y + z')$

$F2' = [x(y'z' + yz)]' = x' + (y'z' + yz)'$

$= x' + (y'z')'(yz)'$

$= x' + (y + z)(y' + z')$

40) Simplify the following expression

$Y = (A + B) (A = C) (B + C)$

$= (A A + A C + A B + B C) (B + C)$

$= (A C + A B + B C) (B + C)$

$= A B C + A C C + A B B + A B C + B B C + B C C$

$= A B C$

41) What are the methods adopted to reduce Boolean function?

i) Karnaug map

ii) Tabular method or Quine Mc-Cluskey method

iii) Variable entered map technique.

42) State the limitations of karnaugh map.

i) Generally it is limited to six variable map (i.e) more then six variable involving expression are not reduced.

ii) The map method is restricted in its capability since they are useful for simplifying only Boolean expression represented in standard form.

43) What is a karnaugh map?

A karnaugh map or k map is a pictorial form of truth table, in which the map diagram is made up of squares, with each squares representing one minterm of the function.

44) Find the minterms of the logical expression $Y = A'B'C' + A'B'C + A'BC + ABC'$

$Y = A'B'C' + A'B'C + A'BC + ABC'$

$= m0 + m1 + m3 + m6$

=_m(0, 1, 3, 6)

45) Write the maxterms corresponding to the logical expression

$Y = (A + B + C')(A + B' + C')(A' + B' + C)$

$= (A + B + C')(A + B' + C')(A' + B' + C)$

$= M1.M3.M6$

=_ M(1,3,6)

46) What are called don’t care conditions?

In some logic circuits certain input conditions never occur, therefore the corresponding output never appears. In such cases the output level is not defined, it can be either high or low. These output levels are indicated by ‘X’ or‘d’ in the truth tables and are called don’t care conditions or incompletely specified functions.

47) What is a prime implicant?

A prime implicant is a product term obtained by combining the maximum possible number of adjacent squares in the map.

48) What is an essential implicant?

If a min term is covered by only one prime implicant, the prime implicant is said to be essential.

Part B

UNIT-I

1) Simplify the Boolean function using tabulation method.
   F= (0, 1, 2, 8, 10, 11, 14, 15)
2) Determine the prime implicants of the function.
   F= (1,4,6,7,8,9,10,11,15)
3) Simplify the Boolean function using K-map.

   F(A,B,C,D,E) = (0,2,4,6,9,13,21,23,25,29,31)
4) Obtain the canonical sum of products of the function Y = AB + ACD Y = AB (C + C')(D + D') + ACD (B + B')

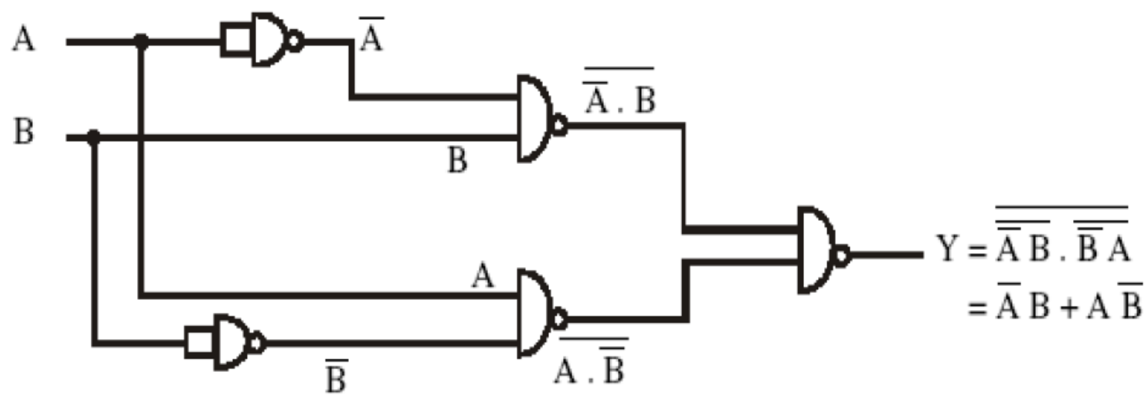
   Y = ABCD + ABCD' + ABC'D + ABC'D' + AB'CD

UNIT – II

COMBINATIONAL CIRCUIT DESIGN

1) What is a Logic gate?

   Logic gates are the basic elements that make up a digital system. The electronic gate is a circuit that is able to operate on a number of binary inputs in order to perform a particular logical function.
2) Implement the Boolean Expression for EX – OR gate using NAND Gates.



3) Define combinational logic

When logic gates are connected together to produce a specified output for certain specified combinations of input variables, with no storage involved, the resulting circuit is called combinational logic.

4) 78. Explain the design procedure for combinational circuits

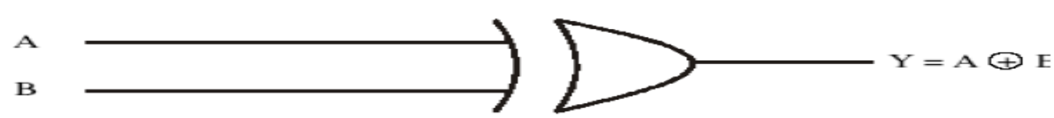
1. The problem definition
2. Determine the number of available input variables & required O/P variables.
3. Assigning letter symbols to I/O variables
4. Obtain simplified Boolean expression for each O/P.
5. Obtain the logic diagram.

5) Define Half adder and full adder

The logic circuit that performs the addition of two bits is a half adder. The circuit that performs the addition of three bits is a full adder.

6) Draw the logic Symbol and construct the truth table for the two input EX – OR gate.

Logic Symbol



Truth Table

Inputs		Output
A	B	Y
O	O	o
O	1	1
1	O	1
1	1	o

7) Define Decoder

A decoder is a multiple - input multiple output logic circuit that converts coded inputs into coded outputs where the input and output codes are different.

8) What is binary decoder?

A decoder is a combinational circuit that converts binary information from n input lines to a maximum of 2n out puts lines.

9) Define Encoder

An encoder has 2n input lines and n output lines. In encoder the output lines generate the binary code corresponding to the input value.

10) What is priority Encoder?

A priority encoder is an encoder circuit that includes the priority function. In priority encoder, if 2 or more inputs are equal to 1 at the same time, the input having the highest priority will take precedence.

11) Define multiplexer

Multiplexer is a digital switch. If allows digital information from several sources to be routed onto a single output line.

12) What do you mean by comparator?

A comparator is a special combinational circuit designed primarily to compare the relative magnitude of two binary numbers.

13) List basic types of programmable logic devices.

1. Read only memory
2. Programmable logic Array
3. Programmable Array Logic

14) Define ROM

Read only memory is a device that includes both the decoder and the OR gates within a single IC package.

15) Define address and word:

In a ROM, each bit combination of the input variable is called on address. Each bit combination that comes out of the output lines is called a word.

16) State the types of ROM

1. Masked ROM.
2. Programmable Read only Memory
3. Erasable Programmable Read only memory.
4. Electrically Erasable Programmable Read only Memory.

17) What is programmable logic array? How it differs from ROM?

In some cases the number of don’t care conditions is excessive, it is more economical to use a second type of LSI component called a PLA. A PLA is similar to a ROM in concept;

however it does not provide full decoding of the variables and does not generates all the minterms as in the ROM.

18) Which gate is equal to AND-invert Gate?

NAND gate.

19) Which gate is equal to OR-invert Gate?

NOR gate.

20) Bubbled OR gate is equal to-------------

- NAND gate

21) Bubbled AND gate is equal to-------------

- NOR gate

UNIT-II

1) Explain the working of BCD Ripple Counter with the help of state diagram and logic diagram.
2) Design a logic circuit to convert the BCD code to Excess – 3 code.
3) Design and explain a comparator to compare two identical words. Two numbers represented by A = A3A2A1A0 & B = B3B2B1B0
4) Design a sequential detector which produces an output 1 every time the input sequence 1011 is detected.
5) Explain in detail about serial in serial out shift register.
6) Implement the switching function F= ∑ (0,1,3,4,7) using a 4 input MUX and explain
7) Explain how will build a 64 input MUX using nine 8 input MUXs
8) Implement the switching function F= ∑ (0,1,3,4,12,14,15) using an 8 input MUX
9) Explain how will build a 16 input MUX using only 4 input MUXs
10) Explain the operation of 4 to 10 line decoder with necessary logic diagram
11) Design full adder and full sub tractor.
12) Design a 4 bit magnitude comparator to compare two 4 bit number
13) Construct a combinational circuit to convert given binary coded decimal number into an Excess 3 code for example when the input to the gate is 0110 then the circuit should generate output as 1001
14) Using a single 7483, draw the logic diagram of a 4 bit adder/sub tractor
15) Realize a Binary to BCD conversion circuit starting from its truth table
16) Design a combinational circuit which accepts 3 bit binary number and converts its equivalent excess 3 codes

17) Explain carry look ahead adder.

18) Draw and explain BCD adder.

22)

UNIT –III

SYNCHRONOUS SEQUENTIAL CIRCUITS

1) What are the classifications of sequential circuits?

   The sequential circuits are classified on the basis of timing of their signals into two types. They are,

   1)Synchronous sequential circuit.

   2)Asynchronous sequential circuit.

2) Define Flip flop.

   The basic unit for storage is flip flop. A flip-flop maintains its output state either at 1 or 0 until directed by an input signal to change its state.

3) What are the different types of flip-flop?

   There are various types of flip flops. Some of them are mentioned below they are,

   RS flip-flop, SR flip-flop D flip-flop JK flip-flop T flip-flop

4) What is the operation of RS flip-flop?

   - When R input is low and S input is high the Q output of flip-flop is set.
   - When R input is high and S input is low the Q output of flip-flop is reset.
   - When both the inputs R and S are low the output does not change
   - When both the inputs R and S are high the output is unpredictable.

5) What is the operation of SR flip-flop?

   - When R input is low and S input is high the Q output of flip-flop is set.
   - When R input is high and S input is low the Q output of flip-flop is reset.
   - When both the inputs R and S are low the output does not change.
   - When both the inputs R and S are high the output is unpredictable.

6) What is the operation of D flip-flop?

   In D flip-flop during the occurrence of clock pulse if D=1, the output Q is set and if D=0, the output is reset.

7) What is the operation of JK flip-flop?

   - When K input is low and J input is high the Q output of flip-flop is set.
   - When K input is high and J input is low the Q output of flip-flop is reset.

- When both the inputs K and J are low the output does not change
- When both the inputs K and J are high it is possible to set or reset the flip-flop (ie) the output toggle on the next positive clock edge.

8) What is the operation of T flip-flop?

T flip-flop is also known as Toggle flip-flop.

- When T=0 there is no change in the output.
- When T=1 the output switch to the complement state (ie) the output toggles.

9) Define race around condition.

In JK flip-flop output is fed back to the input. Therefore change in the output results change in the input. Due to this in the positive half of the clock pulse if both J and K are high then output toggles continuously. This condition is called ‘race around condition’.

10) What is edge-triggered flip-flop?

The problem of race around condition can solved by edge triggering flip flop. The term edge triggering means that the flip-flop changes state either at the positive edge or negative edge of the clock pulse and it is sensitive to its inputs only at this transition of the clock.

11) What is a master-slave flip-flop?

A master-slave flip-flop consists of two flip-flops where one circuit serves as a master and the other as a slave.

12) Define rise time.

The time required to change the voltage level from 10% to 90% is known as rise time(tr).

13) Define fall time.

The time required to change the voltage level from 90% to 10% is known as fall time(tf).

14) Define skew and clock skew.

The phase shift between the rectangular clock waveforms is referred to as skew and the time delay between the two clock pulses is called clock skew.

15) Define setup time.

The setup time is the minimum time required to maintain a constant voltage levels at the excitation inputs of the flip-flop device prior to the triggering edge of the clock pulse in order for the levels to be reliably clocked into the flip flop. It is denoted as t_{setup} .

16) Define hold time.

The hold time is the minimum time for which the voltage levels at the excitation inputs must remain constant after the triggering edge of the clock pulse in order for the levels to be reliably clocked into the flip flop. It is denoted as t_{hold}.

17) Define propagation delay.

A propagation delay is the time required to change the output after the application of the input.

18) Define registers.

A register is a group of flip-flops flip-flop can store one bit information. So an n-bit register has a group of n flip-flops and is capable of storing any binary information/number containing n-bits.

19) Define shift registers.

The binary information in a register can be moved from stage to stage within the register or into or out of the register upon application of clock pulses. This type of bit movement or shifting is essential for certain arithmetic and logic operations used in microprocessors. This gives rise to group of registers called shift registers.

20) What are the different types of shift type?

There are five types. They are,

Serial In Serial Out Shift Register

Serial In Parallel Out Shift Register

Parallel In Serial Out Shift Register

Parallel In Parallel Out Shift Register

Bidirectional Shift Register

21) Explain the flip-flop excitation tables for RS FF.

RS flip-flop

In RS flip-flop there are four possible transitions from the present state to the next state.

They are,

0 $\longrightarrow$ 1transition: This can happen either when R=S=0 or when R=1 and S=0.

0 $\longrightarrow$ 1 transition: This can happen only when S=1 and R=0.

1 $\longrightarrow$ 0 transition: This can happen only when S=0 and R=1.

2 $\longrightarrow$ 1 transition: This can happen either when S=1 and R=0 or S=0 and R=0.

22) Explain the flip-flop excitation tables for JK flip-flop

In JK flip-flop also there are four possible transitions from present state to next state.

They are,

0 → 1 transition: This can happen when J=0 and K=1 or K=0.

0 → 1 transition: This can happen either when J=1 and K=0 or when J=K=1.

1 → 0 transition: This can happen either when J=0 and K=1 or when J=K=1.

2 → 1 transition: This can happen when K=0 and J=0 or J=1.

23) Explain the flip-flop excitation tables for D flip-flop

In D flip-flop the next state is always equal to the D input and it is independent of the present state. Therefore D must be 0 if Q_{n+1} has to 0,and if Q_{n+1} has to be 1 regardless the value of Q_n.

24) Explain the flip-flop excitation tables for T flip-flop

When input T=1 the state of the flip-flop is complemented; when T=0,the state of the flip-flop remains unchanged. Therefore, for→0 and 1→1 transitions T must be 0 and o→0 →1 and 0 transitions must be 1.

25) Define sequential circuit?

In sequential circuits the output variables dependent not only on the present input variables but they also depend up on the past history of these input variables.

26) Give the comparison between combinational circuits and sequential circuits.

Combinational circuits	Sequential circuits
1. Memory unit is not required	1. Memory unity is required
2. Parallel adder is a combinational circuit	2. Serial adder is a sequential circuit

27) What do you mean by present state?

The information stored in the memory elements at any given time define.s the present state of the sequential circuit.

28) What do you mean by next state?

The present state and the external inputs determine the outputs and the next state of the sequential circuit.

29) State the types of sequential circuits?

1. Synchronous sequential circuits
2. Asynchronous sequential circuits

30) Define synchronous sequential circuit

In synchronous sequential circuits, signals can affect the memory elements only at discrete instant of time.

31) Define Asynchronous sequential circuit?

In asynchronous sequential circuits change in input signals can affect memory element at any instant of time.

32) Give the comparison between synchronous & Asynchronous sequential circuits?

Synchronous sequential circuits	Asynchronous sequential circuits.
1.Memory elements are clocked flip-flops	1.Memory elements are either unlocked flip - flops or time delay elements.
2. Easier to design	2. More difficult to design

33) Define flip-flop

Flip - flop is a sequential device that normally samples its inputs and changes its outputs only at times determined by clocking signal.

34) What is race around condition?

In the JK latch, the output is feedback to the input, and therefore changes in the output results change in the input. Due to this in the positive half of the clock pulse if J and K are both high then output toggles continuously. This condition is known as race around condition.

35) What are the types of shift register?

1. Serial in serial out shift register?
2. Serial in parallel out shift register
3. Parallel in serial out shift register
4. Parallel in parallel out shift register
5. Bidirectional shift register shift register

36) State the types of counter?

1. Synchronous counter
2. Asynchronous Counter

37) Give the comparison between synchronous & Asynchronous counters.

Asynchronous counters	Synchronous counters
In this type of counter flip-flops are connected in such a way that output of 1st flip-flop drives the clock for the next flip- flop.	In this type there is no connection between output of first flip-flop and clock input of the next flip - flop
All the flip-flops are Not clocked simultaneously	All the flip-flops are clocked simultaneously

UNIT-III

1) Explain the operation of JK and clocked JK flip-flops with suitable diagrams
2) Draw the state diagram of a JK flip- flop and D flip – flop
3) Design and explain the working of a synchronous mod – 3 counter
4) Design and explain the working of a synchronous mod – 7 counter
5) Design a synchronous counter with states 0,1, 2,3,0,1 …………. Using JK FF
6) Using SR flip flops, design a parallel counter which counts in the sequence 000,111,101,110,001,010,000 ………….
7) Using JK flip flops, design a parallel counter which counts in the sequence 000,111,101,110,001,010,000 ………….
8) Draw and explain Master-Slave JK flip-flop.
9) Draw as asynchronous 4 bit up-down counter and explain its working
10) Using D flip –flop ,design a synchronous counter which counts in the sequence 000, 001, 010, 011, 100, 1001,110,111,000
11) Design a binary counter using T flip – flops to count in the following sequences: 000,001,010,011,100,101,110,111,000 - 000,100,111,010,011,000
12) Design a 3 bit binary Up-Down counter
13) Draw and explain the operation of four bit Johnson counter.

UNIT-IV

ASYNCHRONOUS SEQUENTIAL CIRCUITS

1) What are secondary variables?

   -present state variables in asynchronous sequential circuits

2) What are excitation variables?

   -next state variables in asynchronous sequential circuits

3) What is fundamental mode sequential circuit?
   a. -input variables changes if the circuit is stable
   b. -inputs are levels, not pulses
   c. -only one input can change at a given time
4) What are pulse mode circuits?
   a. -inputs are pulses
   b. -width of pulses are long for circuit to respond to the input
   c. -pulse width must not be so long that it is still present after the new state is reached

5) What is the significance of state assignment?

   a. In synchronous circuits-state assignments are made with the objective of circuit reduction
   b. Asynchronous circuits-its objective is to avoid critical races

6) When do race conditions occur?
   -Two or more binary state variables change their value in response to the change in i/p variable

7) What is non critical race?
   -final stable state does not depend on the order in which the state variable changes
   -race condition is not harmful

8) What is critical race?

   a. -final stable state depends on the order in which the state variable changes
   b. -race condition is harmful

9) When does a cycle occur?

   -asynchronous circuit makes a transition through a series of unstable state

10) What are the different techniques used in state assignment?

   a. -shared row state assignment
   b. -one hot state assignment

11) What are the steps for the design of asynchronous sequential circuit?

   a. -construction of primitive flow table
   b. -reduction of flow table
   c. -state assignment is made
   d. -realization of primitive flow table

12) What is hazard?

   -unwanted switching transients

13) What is static 1 hazard?

   -output goes momentarily 0 when it should remain at 1

14) What is static 0 hazard?

   -output goes momentarily 1 when it should remain at 0

15) What is dynamic hazard?

   -output changes 3 or more times when it changes from 1 to 0 or 0 to 1

16) What is the cause for essential hazards?

   -unequal delays along 2 or more path from same input

17) What is flow table?

-state table of an synchronous sequential network

18) What is SM chart?

a. -describes the behavior of a state machine

b. -used in hardware design of digital systems

19) What are the advantages of SM chart?

a. -easy to understand the operation

b. -east to convert to several equivalent forms

20) What is primitive flow chart?

-One stable state per row

21) What is combinational circuit?

Output depends on the given input. It has no storage element.

22) What is state equivalence theorem?

Two states SA and SB, are equivalent if and only if for every possible input X sequence, the outputs are the same and the next states are equivalent

i. i.e., if SA (t + 1) = SB (t + 1) and ZA = ZB then SA = SB.

23) What do you mean by distinguishing sequences?

Two states, SA and SB of sequential machine are distinguishable if and only if their exists at least one finite input sequence. Which, when applied to sequential machine causes different output sequences depending on whether SA or SB is the initial state.

24) Prove that the equivalence partition is unique

Consider that there are two equivalence partitions exists : PA and PB, and PA) PB. This states that, there exist 2 states Si & Sj which are in the same block of one partition and not in the same block of the other. If Si & Sj are in different blocks of say PB, there exists at least on input sequence which distinguishes Si & Sj and therefore, they cannot be in the same block of PA.

25) Define compatibility.

States Si and Sj said to be compatible states, if and only if for every input sequence that affects the two states, the same output sequence, occurs whenever both outputs are specified and regardless of whether Si on Sj is the initial state.

26) Define merger graph.

The merger graph is defined as follows. It contains the same number of vertices as the state table contains states. A line drawn between the two state vertices indicates each compatible state pair. It two states are incompatible no connecting line is drawn.

27) Define incompatibility.

The states are said to be incompatible if no line is drawn in between them. If implied states are incompatible, they are crossed & the corresponding line is ignored.

28) Explain the procedure for state minimization.

a. Partition the states into subsets such that all states in the same subsets are 1 - equivalent.

b. Partition the states into subsets such that all states in the same subsets are 2 - equivalent.

c. Partition the states into subsets such that all states in the same subsets are 3 - equivalent.

29) Define closed covering.

A Set of compatibles is said to be closed if, for every compatible contained in the set, all its implied compatibles are also contained in the set. A closed set of compatibles, which contains all the states of M, is called a closed covering.

30) Define machine equivalence.

Two machines, M1 and M2 are said to be equivalent if and only if, for every state in M1, there is a corresponding equivalent state in M2 & vice versa.

31) Define state table.

For the design of sequential counters we have to relate present states and next states. The table, which represents the relationship between present states and next states, is called state table.

32) Define total state

The combination of level signals that appear at the inputs and the outputs of the delays define what is called the total state of the circuit.

33) What are the steps for the design of asynchronous sequential circuit?

1. Construction of a primitive flow table from the problem statement.
2. Primitive flow table is reduced by eliminating redundant states using the state reduction
3. State assignment is made
4. The primitive flow table is realized using appropriate logic elements.

34) Define primitive flow table :

It is defined as a flow table which has exactly one stable state for each row in the table. The design process begins with the construction of primitive flow table.

35) What are the types of asynchronous circuits?

1. Fundamental mode circuits
2. Pulse mode circuits

36) Give the comparison between state Assignment Synchronous circuit and state assignment asynchronous circuit.

In synchronous circuit, the state assignments are made with the objective of circuit reduction. In asynchronous circuits, the objective of state assignment is to avoid critical races.

37) What are races?

When 2 or more binary state variables change their value in response to a change in an input variable, race condition occurs in an asynchronous sequential circuit. In case of unequal delays, a race condition may cause the state variables to change in an unpredictable manner.

38) Define non critical race.

If the final stable state that the circuit reaches does not depend on the order in which the state variable changes, the race condition is not harmful and it is called a non critical race.

39) Define critical race.

If the final stable state depends on the order in which the state variable changes, the race condition is harmful and it is called a critical race.

40) What is a cycle?

A cycle occurs when an asynchronous circuit makes a transition through a series of unstable states. If a cycle does not contain a stable state, the circuit will go from one unstable to stable to another, until the inputs are changed.

41) List the different techniques used for state assignment.

1. Shared row state assignment
2. One hot state assignment.

42) Write a short note on fundamental mode asynchronous circuit.

Fundamental mode circuit assumes that. The input variables change only when the circuit is stable. Only one input variable can change at a given time and inputs are levels and not pulses.

43) Write a short note on pulse mode circuit.

Pulse mode circuit assumes that the input variables are pulses instead of level. The width of the pulses is long enough for the circuit to respond to the input and the pulse width must not be so long that it is still present after the new state is reached.

44) Define secondary variables

The delay elements provide a short term memory for the sequential circuit. The present state and next state variables in asynchronous sequential circuits are called secondary variables.

45) Define flow table in asynchronous sequential circuit.

In asynchronous sequential circuit state table is known as flow table because of the behavior of the asynchronous sequential circuit. The stage changes occur in independent of a clock, based on the logic propagation delay, and cause the states to .flow. From one to another.

46) What is fundamental mode?

A transition from one stable state to another occurs only in response to a change in the input state. After a change in one input has occurred, no other change in any input occurs until the circuit enters a stable state. Such a mode of operation is referred to as a fundamental mode.

47) Write short note on shared row state assignment.

Races can be avoided by making a proper binary assignment to the state variables. Here, the state variables are assigned with binary numbers in such a way that only one state variable can change at any one state variable can change at any one time when a state transition occurs. To accomplish this, it is necessary that states between which transitions occur be given adjacent assignments. Two binary are said to be adjacent if they differ in only one variable.

48) Write short note on one hot state assignment.

The one hot state assignment is another method for finding a race free state assignment. In this method, only one variable is active or hot for each row in the original flow table, ie, it requires one state variable for each row of the flow table. Additional row are introduced to provide single variable changes between internal state transitions.

<u>UNIT-IV</u>

1) Explain with neat diagram the different hazards and the way to eliminate them.
2) State with a neat example the method for the minimization of primitive flow table.
3) Design a asynchronous sequential circuit with 2 inputs T and C. The output attains a value of 1 when T = 1 & c moves from 1 to 0. Otherwise the output is 0.
4) Explain in detail about Races.
5) Explain the different methods of state assignment
6) What is the objective of state assignment in asynchronous circuit? Give hazard – free realization for the following Boolean function $f(A,B,C,D) = \sum m(0,2,6,7,8,10,12)$
7) Summarize the design procedure for asynchronous sequential circuit

Discuss on Hazards and races

8) Develop the state diagram and primitive flow table for a logic system that has 2 inputs, x and y and an output z. And reduce primitive flow table. The behavior of the circuit is stated as follows. Initially x=y=0. Whenever x=1 and y = 0 then z=1, whenever x = 0 and y = 1 then z = 0.When x=y=0 or x=y=1 no change in z ot remains in the previous state. The logic system has edge triggered inputs without having a clock .the logic system changes

   State on the rising edges of the 2 inputs. Static input values are not to have any effect in changing the Z output

9) Design an asynchronous sequential circuit with two inputs X and Y and with one output Z. Whenever Y is 1, input X is transferred to Z.When Y is 0, the output does not change for any change in X.

10) Obtain the primitive flow table for an asynchronous circuit that has two inputs x,y and one output Z. An output z =1 is to occur only during the input state xy = 01 and then if the only if the input state xy =01 is preceded by the input sequence.

11) A pulse mode asynchronous machine has two inputs. It produces an output whenever two consecutive pulses occur on one input line only .The output remains at '1' until a pulse has occurred on the other input line. Draw the state table for the machine.

12) Construct the state diagram and primitive flow table for an asynchronous network that has two inputs and one output. The input sequence X1X2 = 00,01,11 causes the output to become 1.The next input change then causes the output to return to 0.No other inputs will produce a 1 output.

13) Discuss on the different types of Hazards that occurs in asynchronous sequential circuits.

14) Write short note on races and cycles that occur in fundamental mode circuits.

15) Define the following terms:

    a. Critical race

    b. non-critical race.

    c. hazard

    d. flow table.

UNIT-V

MEMORY DEVICES AND DIGITAL INTEGRATED CIRCUITS

1) Explain ROM

   A read only memory(ROM) is a device that includes both the decoder and the

OR gates within a single IC package. It consists of n input lines and m output lines. Each bit combination of the input variables is called an address. Each bit combination that comes out of the output lines is called a word. The number of distinct addresses possible with n input variables is 2^n

2) What are the types of ROM?

1.PROM

2.EPROM

3.EEPROM

3) Explain PROM.

PROM (Programmable Read Only Memory) It allows user to store data or program. PROMs use the fuses with material like nichrome and polycrystalline. The user can blow these fuses by passing around 20 to 50 mA of current for the period 5 to 20µs.The blowing of fuses is called programming of ROM. The PROMs are one time programmable. Once programmed, the information is stored permanent.

4) Explain EPROM.

EPROM(Erasable Programmable Read Only Memory)

EPROM use MOS circuitry. They store 1's and 0's as a packet of charge in a buried layer of the IC chip. We can erase the stored data in the EPROMs by exposing the chip to ultraviolet light via its quartz window for 15 to 20 minutes. It is not possible to erase selective information. The chip can be reprogrammed.

5) Explain EEPROM.

EEPROM(Electrically Erasable Programmable Read Only Memory)

EEPROM also use MOS circuitry. Data is stored as charge or no charge on an insulated layer or an insulated floating gate in the device. EEPROM allows selective erasing at the register level rather than erasing all the information since the information can be changed by using electrical signals.

6) What is RAM?

Random Access Memory. Read and write operations can be carried out.

7) Define ROM

A read only memory is a device that includes both the decoder and the OR gates within a single IC package.

8) Define address and word:

In a ROM, each bit combination of the input variable is called on address. Each bit combination that comes out of the output lines is called a word.

9) What are the types of ROM.

1. Masked ROM.
2. Programmable Read only Memory
3. Erasable Programmable Read only memory.
4. Electrically Erasable Programmable Read only Memory.

10) What is programmable logic array? How it differs from ROM?

In some cases the number of don't care conditions is excessive, it is more economical to use a second type of LSI component called a PLA. A PLA is similar to a ROM in concept; however it does not provide full decoding of the variables and does not generates all the minterms as in the ROM.

11) What is mask - programmable?

With a mask programmable PLA, the user must submit a PLA program table to the manufacturer.

12) What is field programmable logic array?

The second type of PLA is called a field programmable logic array. The user by means of certain recommended procedures can program the EPLA.

13) List the major differences between PLA and PAL

PLA:

1. Both AND and OR arrays are programmable and Complex
   Costlier than PAL PAL
2. AND arrays are programmable OR arrays are fixed
   Cheaper and Simpler

14) Define PLD.

Programmable Logic Devices consist of a large array of AND gates and OR gates that can be programmed to achieve specific logic functions.

15) Give the classification of PLDs and define ROM

PLDs are classified as PROM (Programmable Read Only Memory), Programmable Logic Array(PLA), Programmable Array Logic (PAL), and Generic Array Logic(GAL)
PROM - is Programmable Read Only Memory. It consists of a set of fixed AND gates connected to a decoder and a programmable OR array.

16) Define PLA

PLA is Programmable Logic Array(PLA). The PLA is a PLD that consists of a programmable AND array and a programmable OR array.

17) Define PAL

PAL is Programmable Array Logic. PAL consists of a programmable AND array and a fixed OR array with output logic.

18) Why was PAL developed?

It is a PLD that was developed to overcome certain disadvantages of PLA, such as longer delays due to additional fusible links that result from using two programmable arrays and more circuit complexity.

19) Define GAL.

GAL is Generic Array Logic. GAL consists of a programmable AND array and a fixed OR array with output logic.

20) Why the input variables to a PAL are buffered?

The input variables to a PAL are buffered to prevent loading by the large number of AND gate inputs to which available or its complement can be connected.

21) What does PAL 10L8 specify?

PAL - Programmable Logic Array

10 - Ten inputs

L - Active LOW Ouput

8 - Eight Outputs

22) What is CPLD?

CPLDs are Complex Programmable Logic Devices. They are larger versions of PLDs with a centralized internal interconnect matrix used to connect the device macro cells together.

23) Define bit, byte and word.

The smallest unit of binary data is bit. Data are handled in a 8 bit unit called byte. A complete unit of information is called a word which consists of one or more bytes.

24) How many words can a 16x8 memory can store?

A 16x8 memory can store 16,384 words of eight bits each

25) Define address of a memory.

The location of a unit of data in a memory is called address.

26) Define Capacity of a memory.

It is the total number of data units that can be stored.

27) What is Read and Write operation?

The Write operation stores data into a specified address into the memory and the Read operation takes data out of a specified address in the memory.

28) Why RAMs are called as Volatile?

RAMs are called as Volatile memories because RAMs lose stored data when the power is turned OFF.

29) Define ROM.

ROM is a type of memory in which data are stored permanently or semi permanently. Data can be read from a ROM, but there is no write operation

30) Define RAM.

RAM is Random Access Memory. It is a random access read/write memory. The data can be read or written into from any selected address in any sequence.

31) List the two categories of RAMs.

The two categories of RAMs are static RAM (SRAM) and dynamic RAM (DRAM).

32) Define Static RAM and dynamic RAM.

Static RAM uses flip flops as storage elements and therefore store data indefinitely as long as dc power is applied. Dynamic RAMs use capacitors as storage elements and cannot retain data very long without capacitors being recharged by a process called refreshing.

33) List the two types of SRAM.

1. Asynchronous SRAMs
2. Synchronous Burst SRAMs

34) List the basic types of DRAMs

Fast Page Mode DRAM, Extended Data Out DRAM (EDO DRAM), Burst EDO DRAM and Synchronous DRAM.

35) Define a bus.

A bus is a set of conductive paths that serve to interconnect two or more functional components of a system or several diverse systems.

36) Define Cache memory

It is a relatively small, high-speed memory that can store the most recently used instructions or data from larger but slower main memory.

37) What is the technique adopted by DRAMs.

DRAMs use a technique called address multiplexing to reduce the number of address lines.

38) Give the feature of UV EPROM

UV EPROM is electrically programmable by the user, but the store data must be erased by exposure to ultra violet light over a period of several minutes.

39) Give the feature of flash memory.

The ideal memory has high storage capacity, non-volatility; in-system read and write capability, comparatively fast operation. The traditional memory technologies such as ROM, PROM, EEPROM individually exhibits one of these characteristics, but no single technology has all of them except the flash memory.

40) What are Flash memories?

They are high density read/write memories that are non-volatile, which means data can be stored indefinitely without power.

41) List the three major operations in a flash memory.

Programming, Read and Erase operation

42) What is a FIFO memory?

The term FIFO refers to the basic operation of this type of memory in which the first data bit written into the memory is to first to be read out.

43) List basic types of programmable logic devices.

1. Read only memory
2. Programmable logic Array
3. Programmable Array Logic

44) Define ROM.

A read only memory is a device that includes both the decoder and the OR gates within a single IC package.

45) Define address and word:

In a ROM, each bit combination of the input variable is called on address. Each bit combination that comes out of the output lines is called a word.

46) What are the types of ROM?

1. Masked ROM.
2. Programmable Read only Memory
3. Erasable Programmable Read only memory.
4. Electrically Erasable Programmable Read only Memory.

47) What is programmable logic array? How it differs from ROM?

In some cases the number of don’t care conditions is excessive, it is more economical to use a second type of LSI component called a PLA. A PLA is similar to a ROM in concept; however it does not provide full decoding of the variables and does not generates all the min-terms as in the ROM.

48) What is mask - programmable?

With a mask programmable PLA, the user must submit a PLA PLA program table to the manufacturer.

49) Give the comparison between PROM and PLA.

PROM	PLA
And array is fixed and OR array is programmable.	Both AND and OR arrays are Programmable.
Cheaper and simple to use.	Costliest and complex than PROMS.

50) Give the classification of logic families

logic families

1. Bipolar
    1. Saturated
        - 1.1 RTL
        - 1.2 ECL
        - 1.3 I I C
        - 1.4 TTL
    2. Non Saturated
        - 2.1.Schottky TTL
        - 2.2. DTL

2.Unipolar
    1. PMOS
    2. NMOS
    3. CMOS

51) What are the basic digital logic gates?

The three basic logic gates are

1. AND gate
2. OR gate
3. NOT gate

52) Which gates are called as the universal gates? What are its advantages?

The NAND and NOR gates are called as the universal gates. These gates are used to perform any type of logic application.

53) State the classifications of FET devices.

FET is classified as

1. Junction Field Effect Transistor (JFET)
2. Metal oxide semiconductor family (MOS).

54) Mention the classification of saturated bipolar logic families.

The bipolar logic family is classified as follows:

1. RTL- Resistor Transistor Logic
2. DTL- Diode Transistor logic
3. I2L- Integrated Injection Logic
4. TTL- Transistor Transistor Logic
5. ECL- Emitter Coupled Logic

55) Mention the different IC packages?

1. DIP- Dual in line package
2. LCC- Leadless Chip Carrier
3. PLCC- Plastic Leaded Chip carrier
4. PQFP- Plastic Quad Flat Pack
5. PGA- Pin Grid Array

56) Mention the important characteristics of digital IC's?

1. Fan out
2. Power dissipation
3. Propagation Delay
4. Noise Margin
5. Fan In
6. Operating temperature
7. Power supply requirements

57) Define Fan-out?

Fan out specifies the number of standard loads that the output of the gate can drive with out impairment of its normal operation

58) Define Power dissipation.

Power dissipation is measure of power consumed by the gate when fully driven by all its inputs.

59) What is propagation delay?

Propagation delay is the average transition delay time for the signal to propagate from input to output when the signals change in value. It is expressed in ns.

60) Define noise margin?

It is the maximum noise voltage added to an input signal of a digital circuit that does not cause an undesirable change in the circuit output. It is expressed in volts.

61) Define fan in?

Fan in is the number of inputs connected to the gate without any degradation in the voltage level.

62) What is High Threshold Logic?

Some digital circuits operate in environments, which produce very high noise signals. For operation in such surroundings there is available a type of DTL gate which possesses a high threshold to noise immunity. This type of gate is called HTL logic or High Threshold Logic.

63) What are the types of TTL logic?

1. Open collector output
2. Totem-Pole Output
3. Tri-state output.

64) List the different versions of TTL

1.TTL (Std.TTL)
2.LTTL (Low Power TTL)
3.HTTL (High Speed TTL)
4.STTL (Schottky TTL)
5.LSTTL (Low power Schottky TTL)

65) Why totem pole outputs cannot be connected together.

Totem pole outputs cannot be connected together because such a connection might produce excessive current and may result in damage to the devices.

66) State advantages and disadvantages of TTL

Adv:

Easily compatible with other ICs

Low output impedance

Disadv:

Wired output capability is possible only with tristate and open collector types Special circuits in Circuit layout and system design are required.

UNIT-V

1) Explain in detail about PLA with a specific example.
2) Explain with neat diagrams a RAM architecture.
3) Explain in detail about PLA and PAL.

4) Explain with neat diagrams a ROM architecture.

5)Draw a RAM cell and explain its working.

6) Write short notes on (i) RAM (ii) Types of ROM's.

7) List the PLA program table for BCD to Excess -3-code convertor circuits and show its implementation for any two output functions.

8) Generate the following Boolean functions with PAL with 4inputs and 4outputs

9) Y_3=A'BC'D+A'BCD'+A'BCD+ABC'D Y_2=A'BCD'+A'BCD+ABCD

Y_1=A'BC'+A'BC+AB'C+ABC' Y_0=ABCD.

10) Implement the following functions using PLA.

11) $F_1=\sum m(1,2,4,6)$; $F_2=\sum m(0,1,6,7)$ $F_3=\sum m(2,6)$

12) Implement the given functions using PROM and PAL

13) $F_1=\sum m(0,1,3,5,7,9)$; $F_2=\sum m(1,2,4,7,8,10,11)$

14) Implement the given functions using PAL, PLA

15) $F_1=\sum m(0,1,2,4,6,7)$; $F_2=\sum m(1,3,5,7)$; $F_3=\sum m(0,2,3,6)$

16) Draw the block diagram of a PLA device and briefly explain each block.

17) Design a 16 bit ROM array and explain the operation

18) Write short note on Field Programmable Gate Array (FPGA).

19) Explain about TTL with neat diagrams.

20) Discuss all the characteristics of digital IC's.Explain with neat diagram how an open collector TTL operates.

21) Explain the different applications of open collector TTL.

22) Explain in detail about schottky TTL.

23) Explain in detail about three state gate.

24) Explain with necessary diagrams MOS & CMOS.

EC8391 - CONTROL SYSTEM ENGINEERING

Unit - I Control System Modeling

Two marks

1. What is control system?

A system consists of a number of components connected together to perform a specific function. In a system when the output quantity is controlled by varying the input quantity then the system is called control system.

2. What are the two major types of control system?

The two major types of control system are open loop and closed loop system.

3. Define open loop control system.

The control system in which the output quantity has no effect upon the input quantity is called open loop control system. This means that the output is not feedback to the input for correction.

4. Define closed loop control system.

The control system in which the output has an effect upon the input quantity so as to maintain the desired output value is called closed loop control system.

5. What are the components of feedback control system?

The components of feedback control system are plant, feedback path elements, error detector and controller.

6. Define transfer function.

The Transfer Function of a system is defined as the ratio of the Laplace transform of output to Laplace transform of input with zero initial conditions.

7. What are the basic elements used for modeling mechanical translational system? 1. Mass

2. Spring
3. Dashpot.

8. What are the basic elements used for modeling mechanical rotational system?

1. Moment of inertia J,
2. Dashpot with rotational frictional coefficient B and
3. Torsion spring with stiffness K

9. Name two types of electrical analogous for mechanical system.

The two types of analogies for the mechanical system are force voltage and force current analogy.

10. What is Block Diagram?

A Block Diagram of a system is a pictorial representation of the functions performed by each component of the system and shows the flow of signals. The basic elements of block diagram are blocks, branch point and summing point.

11. What is the basis for framing the rules of block diagram reduction technique?

The rules for block diagram reduction technique are framed such that any modification made on the diagram does not alter the input output relation.

12. What is a signal flow graph?

A signal flow graph is a diagram that represents a set of simultaneous algebraic equations. By taking Laplace transform the time domain differential equations governing a control system can be transferred to a set of algebraic equations in s-domain.

13. What is transmittance?

The transmittance is the gain acquired by the signal when it travels from one node to another node in signal flow graph.

14. What is sink and source?

Source is the input node in the signal flow graph and it has only outgoing branches. Sink is a output node in the signal flow graph and it has only incoming branches.

15. Define non touching loop.

The loops are said to be non touching if they do not have common nodes.

16. Write Masons Gain formula.

Masons Gain formula states that the overall gain of the system is $T = (1/\Delta)$ x $(\Delta_k P_k)$

k-No.of forward paths in the signal flow graph.

P_k- Forward path gain of k^{th} forward path

Δ_k =1-[sum of individual loop gains] +[sum of gain products of all possible combinations of two non touching loops]-[sum of gain products of all possible combinations of three non touching loops]+…

k - for that part of the graph which is not touching k^{th} forward path.

17. Write the analogous electrical elements in force voltage analogy for the elements of mechanical translational system.

Force-voltage-e, Velocity-v, current-I, Displacement-x, charge-q

Frictional coeff-B, Resistance-R, Mass-M, Inductance-L, Stiffness-K,
Inverse of capacitance-1/C

18. Write the analogous electrical elements in force current analogy for the Elements of mechanical translational system.

Force-current-i, Velocity-v, voltage-v, Displacement-x, flux-

Frictional coefficient-B, conductance-1/R, Mass-M, capacitance- C, Stiffness-K,
Inverse of inductance-1/L

19. Write the force balance equation of an ideal mass element.

$F = M\, d^2x / dt^2$

20. Write the force balance equation of ideal dashpot.

$F = B\, dx / dt$

21. Write the force balance equation of ideal spring element.

$F = Kx$

22. What is servomechanism?

The servomechanism is a feedback control system in which the output is mechanical position (or time derivatives of position velocity and acceleration)

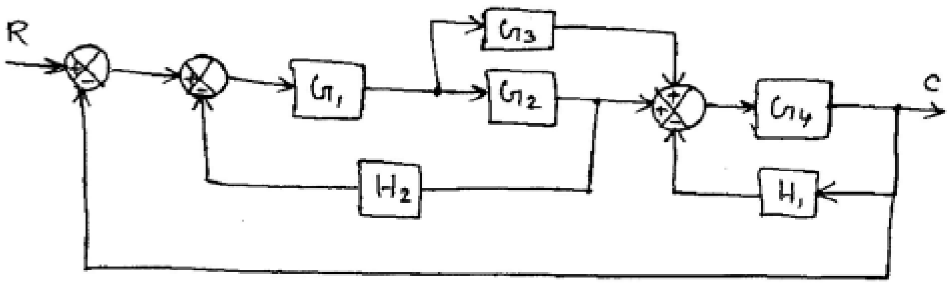
23. Why is negative feedback invariably preferred in closed loop system?

The negative feedback results in better stability in steady state and rejects any disturbance signals.

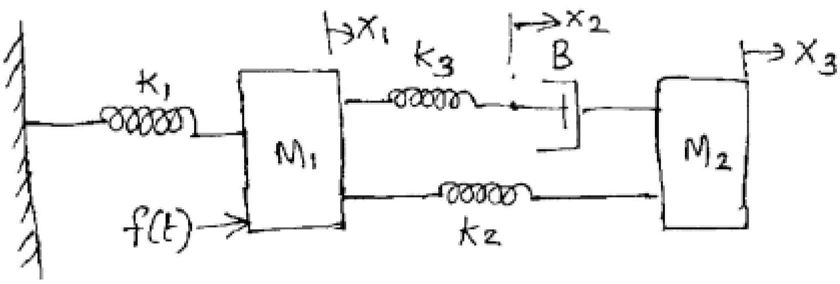
PART B-16 Mark Questions

UNIT - I

1. Draw the signal flow graph and find C/R for the figure shown.

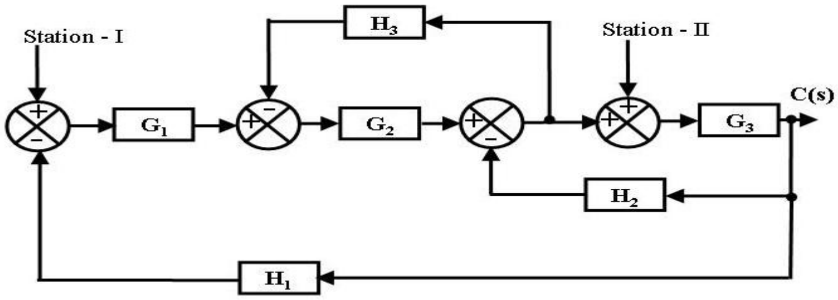


2. Write the differential equations and obtain $X_3(S)/F(S)$ for the mechanical system shown. Also draw the force voltage and force current analogies.

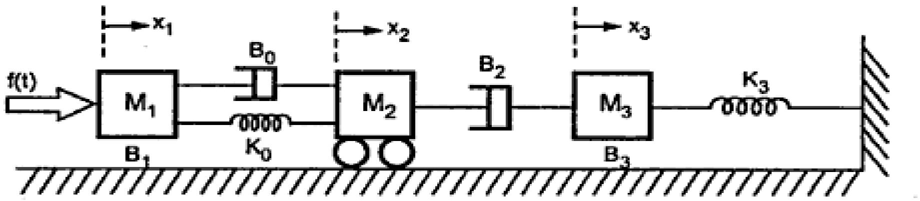


3. a) (i)Reduce the block diagram given below to find the closed loop Transfer function by reduction method when the I/P R is at station-II

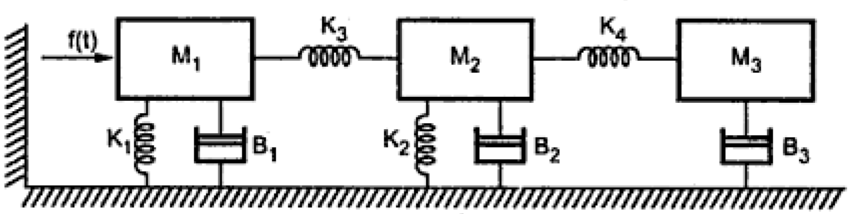
(ii) Reduce the block diagram given above to find the closed loop Transfer function by signal flow graph when the I/P R is at station-I



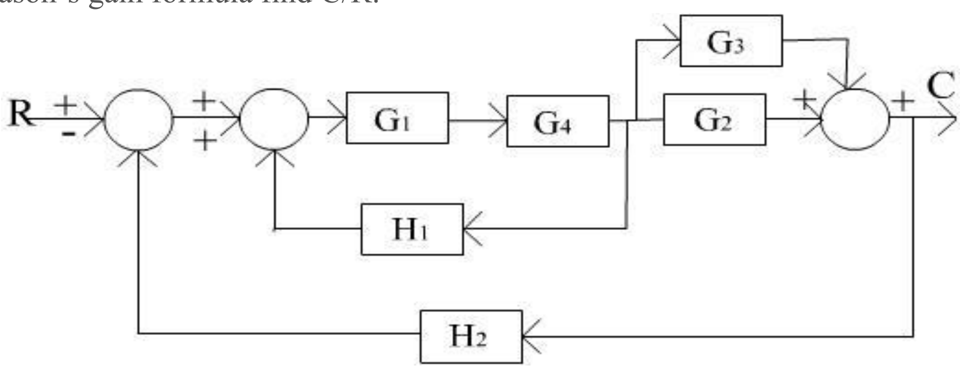
4. Obtain Transfer function of the system.



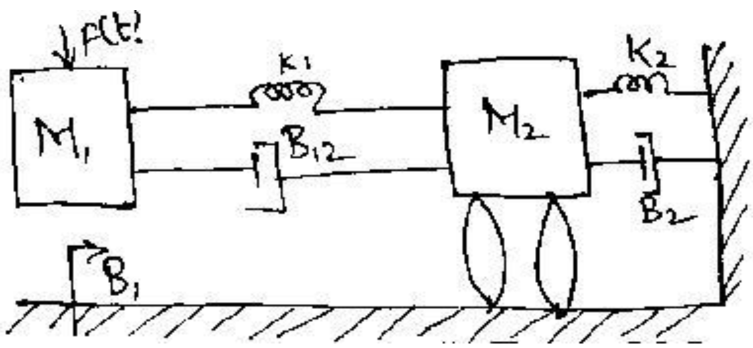
5. Obtain analogous electrical network.



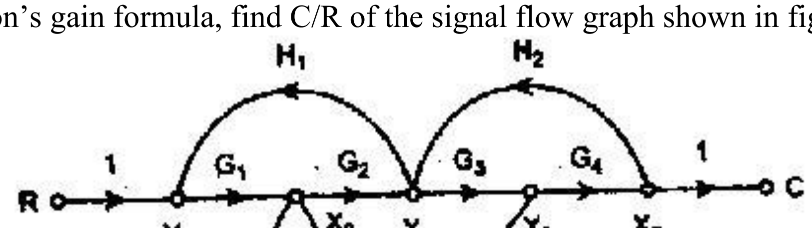
6. Using mason's gain formula find C/R.



7. Write the differential equations governing the mechanical system. Draw the force-voltage and force current electrical analogous circuits and verify by writing mesh and node equations.



8. Using Mason's gain formula, find C/R of the signal flow graph shown in figure.



9. Derive the transfer function for Armature controlled DC servo motor.
10. Derive the transfer function for Field controlled DC servo motor.

Unit - II Time Response Analysis

Two marks

1. What is transient response?

The transient response is the response of the system when the system changes from one state to another.

2. What is steady state response?

The steady state response is the response of the system when it approaches infinity.

3. What is an order of a system?

The order of a system is the order of the differential equation governing the system. The order of the system can be obtained from the transfer function of the given system.

4. Define Damping ratio.

Damping ratio is defined as the ratio of actual damping to critical damping.

5. List the time domain specifications.

The time domain specifications are

i. Delay time

ii. Rise time

iii. Peak time

iv. Peak overshoot

6. Define Delay time.

The time taken for response to reach 50% of final value for the very first time is delay time.

7. Define Rise time.

The time taken for response to raise from 0% to 100% for the very first time is rise time.

8. Define peak time.

The time taken for the response to reach the peak value for the first time is peak time.

9. Define peak overshoot.

Peak overshoot is defined as the ratio of maximum peak value measured from the maximum value to final value.

10. Define Settling time.

Settling time is defined as the time taken by the response to reach and stay within specified error.

11. What is the need for a controller?

The controller is provided to modify the error signal for better control action.

12. What are the different types of controllers?

i. Proportional controller
ii. PI controller
iii. PD controller
iv. PID controller

13. What is Proportional controller?

It is a device that produces a control signal which is proportional to the input error signal.

14. What is PI controller?

It is a device that produces a control signal consisting of two terms - one proportional to error signal and the other proportional to the integral of error signal.

15. What is PD controller?

PD controller is a proportional plus derivative controller which produces an output signal consisting of two time - one proportional to error signal and other proportional to the derivative of the signal.

16. What is the significance of integral controller and proportional controller in a PID controller?

i. The Proportional controller stabilizes the gain but produces a steady state error.
ii. The Integral control reduces or eliminates the steady state error.

17. Why derivative controller is not used in control systems?

The derivative controller produces a control action based on the rate of change of error signal and it does not produce corrective measures for any constant error.

18. Define Steady state error.

The steady state error is defined as the value of error as time tends to infinity.

19. What is the drawback of static coefficients?

The main drawback of static coefficient is that it does not show the variation of error with time and input should be standard input.

20. What is step signal?

The step signal is a signal whose value changes from zero to A at t= 0 and remains constant at A for t>0.

21. What is ramp signal?

The ramp signal is a signal whose value increases linearly with time from an initial value of zero at t=0.the ramp signal resembles a constant velocity.

22. What is a parabolic signal?

The parabolic signal is a signal whose value varies as a square of time from an initial value of zero at t=0.This parabolic signal represents constant acceleration input to the signal.

23. What are the three constants associated with a steady state error?

i. Positional error constant

ii. Velocity error constant

iii.Acceleration error constant

24. What are the main advantages of generalized error coefficients?

i. Steady state is function of time.

ii. Steady state can be determined from any type of input.

25. What are the effects of adding a zero to a system?

Adding a zero to a system results in pronounced early peak to system response thereby the peak overshoot increases appreciably.

26. What is steady state error?

The steady state error is the value of error signal e(t) when t tends to infinity.

27. Name the test signals used in control system.

The commonly used test input signals in control system are impulse step ramp acceleration and sinusoidal signals.

28. What are static error constants?

The K_p, K_v and K_a are called static error constants.

29. What is the disadvantage in proportional controller?

The disadvantage in proportional controller is that it produces a constant steady state error.

30. What is the effect of PD controller on system performance?

The effect of PD controller is to increase the damping ratio of the system and so the peak overshoot is reduced.

31. What is the effect of PI controller on the system performance?

The PI controller increases the order of the system by one, which results in reducing the steady state error .But the system becomes less stable than the original system.

UNIT - II

1. (a) Derive the expressions and draw the response of first order system for unit step input.
   (b) Draw the response of second order system for critically damped case and when input is unit step.
2. Derive the expressions for Rise time, Peak time, Peak overshoot.
3. Derive the response of undamped second order system for unit step input.

4. The unity feedback system is characterized by an open loop transfer function is $\frac{k}{s(s+10)}$.

Determine the gain k so that system will have damping ratio of 0.5.For this value of k, determine peak overshoot and peak time for a unit step input.

5. A positional control system with velocity feedback is shown in fig. What is the response c(t) to the unit step input. Given that ς =0.5.and also calculate rise time, peak time, Maximum overshoot and settling time.
6. A unity feedback control system has an open loop transfer function G(S) = 10/S(S+2).Find the rise time, percentage over shoot, peak time and settling time.
7. Consider a second order model Y(s)/R(s)= ωn2/ (S^2+2ξωnS+ωn^2) ; $0 < \xi < 1$. Find the response y(t) to a input of unit step function..
8. For a unity feedback control system the open loop transfer function G(S) = 10(S+2)/ S^2 (S+1).Find (a) position, velocity and acceleration error constants. (b) The steady state error when the input is R(S) where R(S) =3/S –2/S^2 +1/3S^3
9. The open loop transfer function of a servo system with unity feedback system is G(S) = 10/ S(0.1S+1).Evaluate the static error constants of the system. Obtain the steady state error of the system when subjected to an input given by the polynomial $r(t) = a_0 + a_1 t + a_2 /2\, t^2$.
10. The open loop transfer function of a system with unity feedback gain is given as G(S) = 20/S^2+5S+6. Determine the damping ratio, maximum overshoot, rise time and peak time. Derive the used formulae.
11. Evaluate te static error constants for a unity feedback system having a forward path transfer function G(S)=50/S(S+10). Estimate the steady state errors of the system for the input r(t) given by $r(t)=1+2t+t^2$.
12. The closed loop transfer function of a second order system is given by

$$T(s) = \frac{100}{s^2 + 10s + 100}$$

Determine the damping ratio, natural frequency of oscillations, rise time, settling time and peak overshoot.

13. With necessary diagrams explain the P,PI,PD controller and explain its output equations.

Unit - III Frequency Response Analysis

Two marks

1. What is frequency response?

A frequency response is the steady state response of a system when the input to the system is a sinusoidal signal.

2. List out the different frequency domain specifications.

The frequency domain specifications are

i. Resonant peak.

ii. Resonant frequency.

3. Define Resonant Peak (Δr)

The maximum value of the magnitude of closed loop transfer function is called Resonant Peak.

4. Define Resonant frequency (Δf)

The frequency at which resonant peak occurs is called resonant frequency.

5. What is Bandwidth?

The Bandwidth is the range of frequencies for which the system gain is more than 3 dB. The bandwidth is a measure of the ability of a feedback system to reproduce the input signal noise rejection characteristics and rise time.

6. Define Cut off rate.

The slope of the log-magnitude curve near the cut-off is called cut-off rate. The cut off rate indicates the ability to distinguish the signal from noise.

7. Define Gain Margin.

The Gain Margin, k_g is defined as the reciprocal of the magnitude of the open loop transfer function at phase cross over frequency.

8. Define Gain margin formula. Gain margin
$k_g = 1 / \Delta\ G(j\Delta pc)\Delta$.

9. Define Phase cross over.

The frequency at which, the phase of open loop transfer functions is called phase cross over frequency Δpc.

10. What is Phase margin?

The Phase margin is the amount of phase lag at the gain cross over frequency required to bring system to the verge of instability.

11. Define Gain cross over.

The Gain cross over frequency Δgc is the frequency at which the magnitude of the open loop transfer function is unity.

12. What is Bode plot?

The Bode plot is the frequency response plot of the transfer function of a system. A Bode plot consists of two graphs. One is the plot of magnitude of sinusoidal transfer function versus log Δ. The other is a plot of the phase angle of a sinusoidal function versus log Δ.

13. What are the main advantages of Bode plot?

The main advantages are:

i) Multiplication of magnitude can be into addition.

ii) A simple method for sketching an approximate log curve is available.

iii) It is based on asymptotic approximation. Such approximation is sufficient if rough information on the frequency response characteristic is needed.

iv) The phase angle curves can be easily drawn if a template for the phase angle curve of 1+ jΔ is available.

14. Define Corner frequency.

The frequency at which the two asymptotic meet in a magnitude plot is called Corner frequency.

15. Define Phase lag and phase lead.

A negative phase angle is called phase lag. A positive phase angle is called phase lead.

16. What are M circles?

The magnitude of closed loop transfer function with unit feedback can be shown for every value of M. These circles are called M circles.

17. What is Nichols chart?

The chart consisting if M & N loci in the log magnitude versus phase diagram is called Nichols chart.

18. What are two contours of Nichols chart?

Nichols chart of M and N contours, superimposed on ordinary graph. The M contours are the magnitude of closed loop system in decibels and the N contours are the phase angle locus of closed loop system.

19. How is the Resonant Peak (M_r), resonant frequency (W_r) , and band width determined from Nichols chart?

i) The resonant peak is given by the value of Δ.contour which is tangent to G(jΔ) locus.

ii) The resonant frequency is given by the frequency of G(jΔ) at the tangency point.

iii) The bandwidth is given by frequency corresponding to the intersection point of G(jΔ) and –3dB M-contour.

20. What are the advantages of Nichols chart?

The advantages are:

i) It is used to find the closed loop frequency response from open loop frequency response.

ii) Frequency domain specifications can be determined from Nichols chart.

iii) The gain of the system can be adjusted to satisfy the given specification.

21. What are the two types of compensation?

i. Cascade or series compensation

ii. Feedback compensation or parallel compensation.

22. What are the three types of compensators?

i. Lag compensator

ii. Lead compensator

iii. Lag-Lead compensator.

23. What are the uses of lead compensator?

i. Speeds up the transient response

ii. Increases the margin of stability of a system

iii. Increases the system error constant to a limited extent.

24. What is the use of lag compensator?

Improve the steady state behavior of a system, while nearly preserving its transient response.

25. When lag lead compensator is required?

The lag lead compensator is required when both the transient and steady state response of a system has to be improved.

26. What is a compensator?

A device inserted into the system for the purpose of satisfying the specifications is called as a compensator.

UNIT - III

1. Sketch the Bode plot for the system $G(s) = K(e^{-0.2s})/s(s+2)(s+8)$. Find the value of K so that the system is stable with gain margin = 6 db and phase margin= 45 degree.
2. The open loop transfer function of a unity feedback system is $G(S) = 1/ S(1+S)(1+2S)$. Sketch the Polar plot and determine the Gain margin and Phase margin.
3. Sketch the Bode plot and hence find Gain cross over frequency, Phase cross over frequency, Gain margin and Phase margin. $G(S) = 0.75(1+0.2S)/ S(1+0.5S)(1+0.1S)$
4. Sketch the Bode plot and hence find Gain cross over frequency, Phase cross over frequency, Gain margin and Phase margin. $G(S) = 10(S+3)/ S(S+2)(S^2+4S+100)$
5. Sketch the polar plot for the following transfer function .and find Gain cross over frequency, Phase cross over frequency, Gain margin and Phase margin. $G(S) = 10(S+2)(S+4)/ S(S^2 -3S+10)$
6. Construct the polar plot for the function $GH(S) =2(S+1)/ S^2$. Find Gain cross over frequency, Phase cross over frequency, Gain margin and Phase margin.
7. Plot the Bode diagram for the following transfer function and obtain the gain and phase cross over frequencies. $G(S) =KS^2 / (1+0.2S)(1+0.02S)$. Determine the value of K for a gain cross over frequency of 20 rad/sec.
8. Sketch the polar plot for the following transfer function and find Gain cross over frequency, Phase cross over frequency, Gain margin and Phase margin. $G(S) = 400/ S(S+2)(S+10)$.
9. Derive the expression for Lag - Lead compensator and also find its frequency response.
10. Sketch the Bode plot and hence find Gain cross over frequency, Phase cross over frequency, Gain margin and Phase margin. $G(S) = 10(1+0.1S)/ S(1+0.01S)(1+S)$.
11. Explain the closed loop frequency response with the help of M and N circles.
12. Explain in detail the design procedure of lead compensator using Bode plot.

Unit - IV Stability Analysis

Two marks

1. What is Nyquist contour?

The contour that encloses entire right half of S plane is called Nyquist contour.

2. State Nyquist stability criterion.

If the Nyquist plot of the open loop transfer function G(s) corresponding to the Nyquist control in the S-plane encircles the critical point –1+j0 in the counter clockwise direction as many times as the number of right half S-plane poles of G(s),the closed loop system is stable.

3. Define Relative stability.

Relative stability is the degree of closeness of the system, it is an indication of strength or degree of stability.

4. What are the two segments of Nyquist contour?

i. A finite line segment C_1 along the imaginary axis.

ii. An arc C_2 of infinite radius.

5. What are root loci?

The path taken by the roots of the open loop transfer function when the loop gain is varied from 0 to 1 are called root loci.

6. What is a dominant pole?

The dominant pole is a complex conjugate pair which decides the transient response of the system.

7. What are the main significances of root locus?

i. The main root locus technique is used for stability analysis.

ii. Using root locus technique the range of values of K, for as table system can be determined.

8. What are the effects of adding a zero to a system?

Adding a zero to a system increases peak overshoot appreciably.

9. Define stability.

A linear relaxed system is said to have BIBIO stability if every bounded input results in a bounded output.

10. What will be the nature of impulse response when the roots of characteristic equation are lying on imaginary axis?

If the root of characteristic equation lies on imaginary axis the nature of impulse response is oscillatory.

11. What is the relationship between Stability and coefficient of characteristic polynomial?

If the coefficient of characteristic polynomial are negative or zero, then some of the roots lie on the negative half of the S-plane. Hence the system is unstable. If the coefficients of the characteristic polynomial are positive and if no coefficient is zero then there is a possibility of the system to be stable provided all the roots are lying on the left half of the S-plane.

12. What is Routh stability criterion?

Routh criterion states that the necessary and sufficient condition for stability is that all of the elements in the first column of the routh array is positive. If this condition is not met, the system is unstable and the number of sign changes in the elements of the first column of routh array corresponds to the number of roots of characteristic equation in the right half of the S-plane.

13. What is limitedly stable system?

For a bounded input signal if the output has constant amplitude oscillations, then the system may be stable or unstable under some limited constraints such a system is called limitedly stable system.

14. In Routh array what conclusion you can make when there is a row of all zeros?

All zero rows in the routh array indicate the existence of an even polynomial as a factor of the given characteristic equation. The even polynomial may have roots on imaginary axis.

15. What is a principle of argument?

The principles of arguments states that let F(S) are analytic function and if an arbitrary closed contour in a clockwise direction is chosen in the S-plane so that F(S) is analytic at every point of the contour. Then the corresponding F(S) plane contour mapped in the F(S) plane will encircle the origin N times in the anti clockwise direction, where N is the difference between number of poles and zeros of F(S) that are encircled by the chosen closed contour in the S-plane.

16. What are the main significances of root locus?

i. The root locus technique is used for stability analysis.

ii. Using root locus technique the range of values of K, for as stable system can be determined.

17. What are break away and break in points?

At break away point the root locus breaks from the real axis to enter into the complex plane. At break in point the root locus enters the real axis from the complex plane. To find the break away or break in points, form a equation for K from the characteristic equation and differentiate the equation of K with respect to s. Then find the roots of the equation dK/dS = 0. The roots of dK/dS = 0 are break away or break in points provided for this value of root the gain K should be positive and real.

18. What are asymptotes? How will you find angle of asymptotes?

Asymptotes are the straight lines which are parallel to root locus going to infinity and meet the root locus at infinity.

Angles of asymptotes = ±180°(2q + 1)/(p-z) q= 0,1,2, …….(p-z-1)
p-number of poles.

z-number of zeros.

19. What is centroid?

The meeting point of the asymptotes with the real axis is called centroid. The centroid is given by

Centroid = (sum of poles – sum of zeros) / (p-z)
p-number of poles. z-number of
zeros.

20. What is magnitude criterion?

The magnitude criterion states that $s=s_a$ will be a point on root locus if for that value of S, magnitude of G(S)H(S) is equal to 1.

|G(S)H(S)| = K (product of length of vectors from open loop zeros to the point $s=s_a$)/ (product of length

of vectors from open loop poles to the point $s=s_a$) = 1.

21. What is angle criterion?

The angle criterion states that $s=s_a$ will be the point on the root locus if for that value of S the argument or phase of G(S)H(S) is equal to an odd multiple of 180°.

(Sum of the angles of vectors from zeros to the point $s=s_a$) - (Sum of the angles of vectors from poles to the point $s=s_a$) = $\pm 180°(2q + 1)$

22. How will you find the root locus on real axis?

To find the root loci on real axis, choose the test point on real axis. If the total number of poles and zeros on the real axis to the right of this test point is odd number then the test point lie on the root locus. If it is even then the test point does not lie on the root locus.

23. What is characteristic equation?

The denominator polynomial of C(S)/R(S) is the characteristic equation of the system.

24. How the roots of characteristic are related to stability?

If the root of characteristic equation has positive real part then the impulse response of the system is not bounded. Hence the system will be unstable. If the root has negative real parts then the impulse response is bounded. Hence the system will be stable.

25. What is the necessary condition for stability?

The necessary condition for stability is that all the coefficients of the characteristic polynomial be positive. The necessary and sufficient condition for stability is that all of the elements in the first column of the routh array should be positive.

26. What are the requirements for BIBO Stability?

The requirement of the BIBO stability is that the absolute integral of the impulse response of the system should take only the finite value.

27. What is auxiliary polynomial?

In the construction of routh array a row of all zero indicates the existence of an even polynomial as a factor of given characteristic equation. In an even polynomial the exponents of S are even integers or zero only. This even polynomial factor is called auxiliary polynomial. The coefficients of auxiliary polynomial are given by the elements of the row just above the row of all zeros.

UNIT - IV

1. Obtain Routh array for the system whose characteristic polynomial equation is given by $s^6+2s^5+8s^4+12s^3+20s^2+16s+16=0$. Comment on location of roots and check the stability.
2. $F(S)=S^6+S^5-2S^4-3S^3-7S^2-4S^1-4=0$.Find the number of roots falling in the RHS plane and LHS plane.
3. Draw the Nyquist plot for the system whose open loop transfer function is G(S)H(S) =K/S (S+2) (S+10).Determine the range of K for which closed loop system is stable.
4. Construct Nyquist plot for a feedback control system whose open loop transfer function is given by G(S)H(S) =5/ S(1-S).comment on the stability of open loop and closed loop transfer function.

5. Sketch the Nyquist plot for a system with the open loop transfer function G(S)H(S) =K(1+0.5S) (1+S) / (1+10S) (S-1).determine the range of values of K for which the system is stable.
6. The open loop transfer function of a unity feedback system is given by G(S) = K/(S+2)(S+4)(S^2+6S+25) by applying the Routh criterion, discuss the stability of the closed loop system as a function of K. Determine the value of K which will cause sustained oscillations in the closed loop system. What are the corresponding oscillation frequencies?
7. Sketch the root locus of the system having G(S)H(S)=K(S+2)/(S+1)(S+3+j2)(S+3-j2) for positive value of K.
8. Sketch the root locus for unity feedback system whose open loop transfer function is

$$G(s) = \frac{K(s^2+6s+25)}{s(s+1)(s+2)}$$

9. Sketch the root locus plot of a unity feedback system with an open loop transfer function G(s) = K / s (s+2) (s+4). Determine the value of K so that the dominant pair of complex poles of the system has a damping ratio of 0.5.
10. Sketch the root locus of unity feedback system whose open loop transfer function is G(s)H(s)=K/s(s+4)(s^2+4s+13). Find the marginal value of K which causes sustained oscillations and find the frequency of these oscillations.
11. Sketch the root locus of the system having $G(s) = \frac{k(s+3)}{s(s+1)(s+2)(s+4)}$.

Unit - V State Variable Analysis

Two marks

1. State sampling theorem.

A continuous time signal can be completely represented in its samples and recovered back if the sampling frequency Fs≥2Fmax where Fs is the sampling frequency and Fmax is the maximum frequency present in the signal.

2. What is periodic sampling?

Sampling of a signal at uniform equal intervals is called periodic sampling.

3. What are hold circuits & explain it.

The function of the hold circuit is to reconstruct the signal which is applied as input to the sampler. The simplest holding device holds the signal between two consecutive instants at its preceded value till next sampling instant is reached.

4. What are the problems encountered in a practical hold circuits?

Hold mode may drop occur, nonlinear variation during sampling aperture, error in the periodicity of sampling.

5. What are the advantages of state space analysis?

It can be applied to non-linear as well as time varying systems. Any type of input can be considered for designing the system. It can be conveniently applied to multiple input multiple output systems. The state variables selected need not necessarily be the physical quantities of the system.

6. What are phase variables?

The phase variables are defined as the state variables which are obtained from one of the system variables and its derivatives.

7. Define state variable.

The state of a dynamical system is a minimal set of variables(known as state variables) such that the knowledge of these variables at $t\text{-}t_0$ together with the knowledge of the inputs for $t > t_0$, completely determines the behavior of the system for $t > t_0$.

8. Write the general form of state variable matrix.

The most general state-space representation of a linear system with m inputs, p outputs and n state variables is written in the following form:

= AX + BU

Y = CX + DU

Where = state vector of order n X 1. U = input vector of order n X1. A=System matrix of order n X n. B=Input matrix of order n X m

C =output matrix of order p X n

D = transmission matrix of order p X m.

9. Write the relationship between z-domain and s-domain.

All the poles lying in the left half of the S-plane, the system is stable in S-domain. Corresponding in Z-domain all poles lie within the unit circle.

10. What are the methods available for the stability analysis of sampled data control system?

The following three methods are available for the stability analysis of sampled data control system

1. Jury's stability test.
2. Bilinear transformation.
3. Root locus technique.

11. What is the necessary condition to be satisfied for design using state feedback?

The state feedback design requires arbitrary pole placements to achieve the desire performance. The necessary and sufficient condition to be satisfied for arbitrary pole placement is that the system is completely state controllable.

12. What is controllability?

A system is said to be completely state controllable if it is possible to transfer the system state from any initial state $X(t_0)$ at any other desired state X(t), in specified finite time by a control vector U(t).

13. What is observability?

A system is said to be completely observable if every state X(t) can be completely identified by measurements of the output Y(t) over a finite time interval.

14. Write the properties of state transition matrix.

The following are the properties of state transition matrix

$\Phi(0) = e^{Ax0} = I$ (unit matrix).

$\Phi(t) = e^{At} = (e^{-At})^{-1} = [\Phi(-t)]^{-1}$.

$\Phi(t_1+t_2) = e^{A(t1+t2)} = \Phi(t_1)\,\Phi(t_2) = \Phi(t_2)\,\Phi(t_1)$.

15. What is sampled data control system?

When the signal or information at any or some points in a system is in the form of discrete pulses, then the system is called discrete data system or sampled data system.

16. What is Nyquist rate?

The Sampling frequency equal to twice the highest frequency of the signal is called as Nyquist rate. $f_s=2f_m$.

17. What is meant by diagonalization?

The process of converting the system matrix A into a diagonal matrix by a similarity transformation using the modal matrix M is called diagonalization.

18. What is modal matrix?

The modal matrix is a matrix used to diagonalize the system matrix. It is also called diagonalization matrix.

If A = system matrix.

M = Modal matrix

And M^{-1}=inverse of modal matrix.

Then $M^{-1}AM$ will be a diagonalized system matrix.

19. How the modal matrix is determined?

The modal matrix M can be formed from eigenvectors. Let m_1, m_2, m_3 …. m_n be the eigen vectors of the n^{th} order system. Now the modal matrix M is obtained by arranging all the eigenvectors column wise as shown below.

Modal matrix , $M = [m_1, m_2, m_3 \ldots m_n]$.

20. What is the need for controllability test?

The controllability test is necessary to find the usefulness of a state variable. If the state variables are controllable then by controlling (i.e. varying) the state variables the desired outputs of the system are achieved.

21. What is the need for observability test?

The observability test is necessary to find whether the state variables are measurable or not. If the state variables are measurable then the state of the system can be determined by practical measurements of the state variables.

22. State the condition for controllability by Gilbert's method.

Case (i) when the eigen values are distinct

Consider the canonical form of state model shown below which is obtained by using the transformation X=MZ.

= ΛZ + U

Y=Z + DU

Where, $\Lambda = M^{-1}AM$; = CM , = $M^{-1}B$ and M = Modal matrix.

In this case the necessary and sufficient condition for complete controllability is that, the matrix must have no row with all zeros. If any row of the matrix is zero then the corresponding state variable is uncontrollable.

Case (ii) when eigen values have multiplicity

In this case the state modal can be converted to Jordan canonical form shown below = JZ + U

Y=Z + DU Where, $J = M^{-1}AM$

In this case the system is completely controllable, if the elements of any row of that correspond to the last row of each Jordan block are not all zero.

23. State the condition for observability by Gilbert's method.

Consider the transformed canonical or Jordan canonical form of the state model shown below which is obtained by using the transformation, X =MZ

= ΛZ + U

Y=Z + DU (Or)

= JZ + U

Y=Z + DU where =CM and M=modal matrix.

The necessary and sufficient condition for complete observability is that none of the columns of the matrix be zero. If any of the column is of has all zeros then the corresponding state variable is not observable.

24. State the duality between controllability and observability.

The concept of controllability and observability are dual concepts and it is proposed by kalman as principle of duality. The principle of duality states that a system is completely state controllable if and only if its dual system is completely state controllable if and only if its dual system is completely observable or vice versa.

25. What is the need for state observer?

In certain systems the state variables may not be available for measurement and feedback. In such situations we need to estimate the un measurable state variables from the knowledge of input and output. Hence a state observer is employed which estimates the state variables from the input and output of the system. The estimated state variable can be used for feedback to design the system by pole placement.

26. How will you find the transformation matrix, P_o to transform the state model to observable phase variable form?

i. Compute the composite matrix for observability,Q_0

ii. Determine the characteristic equation of the system $|\lambda I - A| = 0$.

iii. Using the coefficients $a_1, a_2, \ldots a_{n-1}$ of characteristic equation form a matrix, W.

iv. Now the transformation matrix, P_0 is given by $P_0 = W\, Q_0^T$.

27. Write the observable phase variable form of state model.

The observable phase variable form of state model is given by the following equations = A_0Z + B_0u.

Y =C_0Z + Du

Where, A_0 = , B_0 = and C_0 = [0 0 ….. 0 1]

28. What is the pole placement by state feedback?

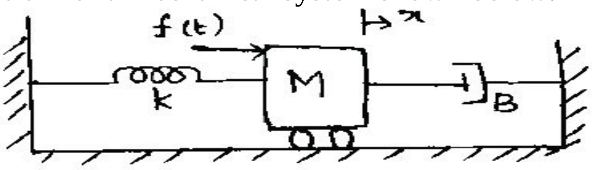
The pole placement by state feedback is a control system design technique, in which the state variables are used for feedback to achieve the desired closed loop poles.

29. How control system design is carried in state space?

In state space design of control system, any inner parameter or variable of a system are used for feedback to achieve the desired performance of the system. The performance of the system is related to the location of closed loop poles. Hence in state space design the closed loop poles are placed at the desired location by means of state feedback through an appropriate state feedback gain matrix, K.

UNIT - V

1. The transfer function of a control system is given by $\frac{Y(s)}{U(s)} = \frac{(s+2)}{s^3+9s^2+26s+24}$. Check for controllability.
2. Find the state variable equation for a mechanical system shown below.



3. A system is characterized by the transfer function $\frac{Y(s)}{U(s)} = \frac{3}{s^3+5s^2+11s+6}$.Identify the first state as the output. Determine whether or not the system is completely controllable and observable.
4. Explain the analysis of sampler and zero-order hold circuits.
5. Obtain the state transition matrix for the state model whose system matrix A is given by

$$A=\begin{bmatrix} 1 & 1 \\ 0 & 1 \end{bmatrix}$$

6. Determine the transfer matrix from the data given below.

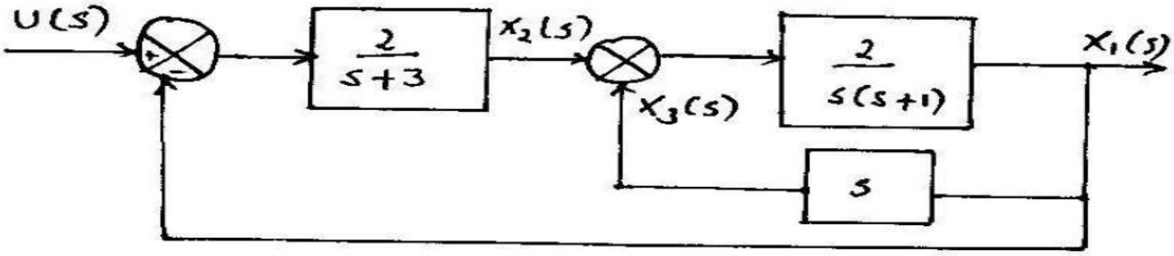
$$A=\begin{bmatrix} -3 & 1 \\ 0 & -1 \end{bmatrix} \quad B=\begin{bmatrix} 1 \\ 1 \end{bmatrix} \quad C=[1\ \ 1] \quad D=0$$

7. The state space representation of a system is given below. Obtain the transfer function.

$$\begin{pmatrix} \dot{x}_1 \\ \dot{x}_2 \\ \dot{x}_3 \end{pmatrix} = \begin{pmatrix} -2 & 1 & 0 \\ 0 & -3 & 1 \\ -3 & -4 & -5 \end{pmatrix} \begin{pmatrix} x_1 \\ x_2 \\ x_3 \end{pmatrix} + \begin{pmatrix} 0 \\ 0 \\ 1 \end{pmatrix} u$$

$$y = \begin{pmatrix} 0 & 1 & 0 \end{pmatrix} \begin{pmatrix} x_1 \\ x_2 \\ x_3 \end{pmatrix}$$

8. A system is characterized by the transfer function $\frac{Y(s)}{U(s)} = \frac{3}{s^3 + 5s^2 + 11s + 6}$. Identify the first state as the output. Determine whether or not the system is completely controllable and observable.
9. Write the state equation for the system shown below in which x1,x2 and x3 constitute the state vector. Determine whether the system is completely controllable and observable.



10. Obtain the state model of the system described by the following transfer function.

$$\frac{Y(s)}{U(s)} = \frac{5}{s^3 + 5s^2 + 6s + 7}$$

11. Determine the state model of armature and field controlled dc motor.
12. (i) Explain the analysis of sampler and zero order hold circuits.
    (ii) Find the inverse Z- transform of $F(Z) = \{(3Z^2+2Z+1)/(Z^2-3Z+2)\}$.