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DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

Regulation: R20 **Year: II-I** **Academic Year: 2023-24**

Subject/Laboratory name: RVSP

Course Instructor(s): S.RAM KUMAR

MID-1 Question Paper

Time: 02:50 pm to 04:20 pm Date: 07.10.2023 Section: ECE-A&B

Answer the following questions **Max. Marks : 30**

1. a) State and prove the properties of cumulative distribution function (CDF) of X.
   b) If the probability density function of a random variable X is given by $f_X(x)=x^2/3;-1\leq X\leq 2$ and 0 ;elsewhere then Find $P(0<X<1)$ and $F_X(x)$?
2. a) State and prove the Chebychev's inequality theorem.
   b) Show that any characteristic function $\phi_X(W)$ satisfies $\phi_X(W)\leq \phi_X(0)=1$.
3. a) Explain about Transformation of random variable.
   b) Write the properties of Joint Distribution function

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DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

Regulation: R20 **Year: II-I** **Academic Year: 2023-24**

Subject/Laboratory name: RVSP

Course Instructor(s): S. RAM KUMAR

Subject: RVSP Time: 02:50 pm to 04:20 pm Date: 07.10.2023 Section: ECE-A&B

MID-1 Question Paper Scheme of Valuation with KEY

1. a) State and prove the properties of cumulative distribution function (CDF) of X.

Ans:CDF of a random variable 'X' is a function which can be defined as,

$FX(x) = P(X \leq x)$
$P(a < X \leq b) = Fx(b) - Fx(a)$
. The CDF of a continuous random variable 'X' can be written as integral of a probability density function. The 'r' cumulative distribution function represents the random variable that contains specified distribution.
Understanding the Properties of CDF
Every CDF function is right continuous and it is non increasing. Where Fx(x) = 0, \
If 'X' is a discrete random variable then its values will be x1, x2, the probability Pi = p(xi) thus the CDF of the random variable 'X' is discontinuous at the points of xi. $FX(x) = P(X \leq x) = \Sigma xi \leq x\ P(X = xi) = \Sigma xi \leq x\ p(xi)$.
If the CDF of a real-valued function is said to be continuous, then 'X' is called a continuous random variable $Fx(b) - Fx(a) = P(a < X \leq b) = \int ab\ fX(x)\ dx$.
The function fx = derivative of Fx is the probability density function of X.

- Complementary Cumulative Distribution Function: It is also known as tail distribution or exceedance, it is defined as, $Fx(x)=P(X>x)=1-FX(x)$
- Folded Cumulative Distribution: When the cumulative distributive function is plotted, and the plot resembles an 'S' shape it is known as FCD or mountain plot.
- Empirical Distribution Function: The estimation of cumulative distributive function that has points generated on a sample is called empirical distribution function.

1.b)If the probability density function of a random variable X is given by fX (x)=x2/3;-1≤X≤2 and 0 ;elsewhere then Find P(0<X<1) and Fx (x)?

Ans:To find the probability P(0<X<1), we need to integrate the probability density function (pdf) fX(x) over the interval 0<x<1.

P(0<X<1) = ∫[0,1] fX(x) dx

= ∫[0,1] (x^2)/3 dx

= (1/3) ∫[0,1] x^2 dx

= (1/3) [(1/3)x^3] from 0 to 1

= (1/3) [(1/3)(1^3 - 0^3)]

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$= (1/3)\ [(1/3)(1)]$

$= 1/9$

To find the cumulative distribution function (cdf) Fx(x), we need to integrate the pdf fX(x) from $-\infty$ to x.

For $x < -1$, $Fx(x) = 0$ (since $fX(x) = 0$ for $x < -1$)

For $-1 \le x < 0$, $Fx(x) = \int[-1,x]\ (t^2)/3\ dt$

$= (1/3) \int[-1,x]\ t^2\ dt$

$= (1/3)\ [(1/3)t^3]$ from -1 to x

$= (1/3)\ [(1/3)(x^3 - (-1)^3)]$

$= (1/3)\ [(1/3)(x^3 + 1)]$

For $0 \le x < 2$, $Fx(x) = \int[-1,x]\ (t^2)/3\ dt$

$= \int[-1,0]\ (t^2)/3\ dt + \int[0,x]\ (t^2)/3\ dt$

$= 0 + (1/3) \int[0,x]\ t^2\ dt$

$= (1/3)\ [(1/3)t^3]$ from 0 to x

$= (1/3)\ [(1/3)(x^3 - 0^3)]$

$= (1/3)\ [(1/3)x^3]$

$= (1/9)x^3$

2. a) State and prove the Chebychev's inequality theorem.

Ans: Chebychev's Inequality Theorem is a fundamental concept in probability theory.

Statement of Chebychev's Inequality Theorem:

Let X be a random variable with a finite expected value $E(X) = \mu$ and a finite variance $Var(X) = \sigma^2$. Then, for any positive real number k, the following inequality holds:

$P(|X - \mu| \ge k\sigma) \le 1/k^2$

Proof of Chebychev's Inequality Theorem:

To prove Chebychev's Inequality, we'll use the following steps:

Step 1: Define the event $A = \{|X - \mu| \ge k\sigma\}$.

Step 2: Use Markov's inequality, which states that for any non-negative random variable Y and any positive real number a:

$P(Y \ge a) \le E(Y)/a$

In this case, let $Y = (X - \mu)^2$ and $a = (k\sigma)^2$.

Step 3: Apply Markov's inequality:

$P((X - \mu)^2 \geq (k\sigma)^2) \leq E[(X - \mu)^2] / (k\sigma)^2$

Step 4: Simplify the expression:

$P(|X - \mu| \geq k\sigma) \leq E[(X - \mu)^2] / (k\sigma)^2$

Step 5: Recognize that $E[(X - \mu)^2]$ is the definition of variance (σ^2):

$P(|X - \mu| \geq k\sigma) \leq \sigma^2 / (k\sigma)^2$

Step 6: Simplify the expression:

$P(|X - \mu| \geq k\sigma) \leq 1/k^2$

This completes the proof of Chebychev's Inequality Theorem.

Interpretation:

Chebychev's Inequality provides a bound on the probability of a random variable deviating from its mean by more than k standard deviations. The inequality states that this probability is less than or equal to $1/k^2$.

This theorem has numerous applications in probability theory, statistics, and engineering, particularly in situations where the distribution of the random variable is unknown or difficult to analyze.

2.b) Show that any characteristic function $\phi X(W)$ satisfies $\phi X(W) \leq \phi X(0)=1$.

Ans: A fundamental property of characteristic functions!

Let's start with the definition of the characteristic function:

$\phi X(W) = E[e^{jWX}]$

$= \int e^{jWx} fX(x)\, dx$

where fX(x) is the probability density function (pdf) of the random variable X.

Now, we'll use the fact that the absolute value of the integral is less than or equal to the integral of the absolute value:

$|\phi X(W)| = |\int e^{jWx} fX(x)\, dx|$

$\leq \int |e^{jWx} fX(x)|\, dx$

$= \int fX(x)\, dx$

$= 1$

The last equality holds because the integral of the pdf fX(x) over the entire real line is equal to 1.

Now, let's evaluate $\phi X(0)$:

$\phi X(0) = E[e^{(j0X)}]$

$= E[1]$

$= 1$

Therefore, we have:

$|\phi X(W)| \leq \phi X(0) = 1$

Since $\phi X(W)$ is a complex-valued function, we can write:

$\phi X(W) = |\phi X(W)|\, e^{(j\theta)}$

where θ is the phase angle.

Taking the absolute value of both sides:

$|\phi X(W)| = |\phi X(W)|$

Since $|\phi X(W)| \leq 1$, we can conclude that:

$\phi X(W) \leq \phi X(0) = 1$

3. a) Explain about Transformation of random variable.

Ans:Transformation of a random variable is a mathematical process that reassigns the values of a random variable to a new variable. This process is used to understand how data behaves and is distributed after a transformation.
Here are some examples of transformations of random variables:

- **Linear transformation**

  In this transformation, every value of the variable is multiplied by a constant, added to a constant, or both. For example, if $X$is a random variable representing the height of students in a class, then Y=X+5.

- **Bivariate transformation**

  This transformation involves two random variables and considers their joint distribution.

- **General transformation**

  This transformation is used to model a new random variable that depends on the original random variable through a transformation. For example, if the velocity of a particle is distributed according to a random variable, then the kinetic energy of the particle is a new random variable that depends on the original random variable.

Transformations can simplify the relationships between variables, making the data easier to interpret and manage. fundamental concept in probability theory!

Transformation of a random variable is a technique used to convert a random variable from one distribution to another. This is useful in various applications, such as:

1. Simplifying complex distributions: By transforming a random variable, we can convert a complex distribution into a simpler one, making it easier to analyze.
2. Generating new distributions: Transformation can be used to generate new distributions from existing ones.
3. Modeling real-world phenomena: Transformation can be used to model real-world phenomena, such as converting a uniform distribution to a normal distribution.

Types of Transformations:

1. Linear Transformation: A linear transformation is of the form Y = aX + b, where a and b are constants.
2. Non-Linear Transformation: A non-linear transformation is of the form Y = g(X), where g is a non-linear function.
3. Monotonic Transformation: A monotonic transformation is a transformation that preserves the order of the values.

Methods of Transformation:

1. Distribution Function Method: This method involves using the distribution function (CDF) of the original random variable to find the distribution function of the transformed random variable.
2. Probability Density Function Method: This method involves using the probability density function (PDF) of the original random variable to find the probability density function of the transformed random variable.
3. Moment Generating Function Method: This method involves using the moment generating function (MGF) of the original random variable to find the moment generating function of the transformed random variable.

Examples:

1. Uniform to Exponential Transformation: If X is uniformly distributed over [0,1], then Y = -λ * ln(X) is exponentially distributed with parameter λ.
2. Normal to Log-Normal Transformation: If X is normally distributed with mean μ and variance σ^2, then Y = e^X is log-normally distributed with parameters μ and σ^2.

These are just a few examples of transformation of random variables. The key idea is to use the distribution function, probability density function, or moment generating function of the original random variable to find the distribution of the transformed random variable.

3b) Write the properties of Joint Distribution function

Ans: Here are the properties of Joint Distribution Function:

Properties of Joint Distribution Function

1. Non-Negativity: $F_{XY}(x,y) \geq 0$ for all x and y.

2. Right-Continuity: $F_{XY}(x,y)$ is right-continuous in both x and y.

3. Monotonicity: $F_{XY}(x_2,y_2) - F_{XY}(x_1,y_1) \geq 0$ for all $x_1 < x_2$ and $y_1 < y_2$.

4. Commutativity: $F_{XY}(x,y) = F_{YX}(y,x)$.

5. Boundary Conditions:
   $F_{XY}(-\infty,y) = 0$ for all y.
   $F_{XY}(x,-\infty) = 0$ for all x.
   $F_{XY}(\infty,\infty) = 1$.

6. Relationship with Marginal Distribution Functions:
   $F_X(x) = F_{XY}(x,\infty)$.
   $F_Y(y) = F_{XY}(\infty,y)$.

7. Joint Probability Density Function (PDF):
   If $F_{XY}(x,y)$ is differentiable, then the joint PDF is given by $f_{XY}(x,y) = \partial^2 F_{XY}(x,y)/\partial x \partial y$.

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MID-2 Question Paper

Time: 02:50 pm to 04:20 pm Date: 01.12.2023 Section: ECE-A&B

Answer the following questions **Max. Marks : 30**

1. a) Two statistically independent random variables X and Y have respective densities $fx(x)=5e^{-5x}u(x)$, $fy(y)=2e^{-2y}u(y)$. Find the density of the sum W = X +Y.
   b) Gaussian random variables X and Y have first and second order moments m_{10}=-1.1, m_{20}=1.16, m_{01}=1.5, m_{02} =2.89, R_{XY}=-1.724. Find C_{XY}, ρ.
2. a) The auto correlation function for a stationary ergodic process with no periodic components is $R_{XX}(\tau)$=625+(16/1+36 τ2).Find mean and variance of the random process.
   b) Explain about Poisson random processes.
3. a) A Random signal X(t) of PSD of $N_0/2$ is applied on an LTI system having impulse response h(t). If y(t) is output, find (i)$E[Y^2]$ (ii)$R_{XY}(\tau)$ (iii) $R_{YY}(\tau)$.
   b) Derive the relationship between Auto-power spectral density and Auto correlation function.

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DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

Regulation: R20 **Year: II-I** **Academic Year: 2023-24**

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MID-2 Question Paper Scheme of evaluation

Time: 02:50 pm to 04:20 pm Date: 01.12.2023 Section: ECE-A&B

Scheme of evaluation with KEY

1. a) Two statistically independent random variables X and Y have respective densities $f_X(x)=5e^{-5x}u(x)$, $f_Y(y)=2e^{-2y}u(y)$. Find the density of the sum W = X +Y.

Ans: To find the density of the sum W = X + Y, we can use the convolution formula, which states that if X and Y are independent random variables with densities f_X(x) and f_Y(y), respectively, then the density of their sum W = X + Y is given by:

f_W(w) = ∫ f_X(x) f_Y(w-x) dx
In this case, we have:
f_X(x) = 5e^(-5x)u(x)
f_Y(y) = 2e^(-2y)u(y)
where u(x) is the unit step function.
Now, we can plug these densities into the convolution formula:
f_W(w) = ∫ 5e^(-5x)u(x) 2e^(-2(w-x))u(w-x) dx
To evaluate this integral, we need to consider the regions where the unit step functions are non-zero.
For x < 0, u(x) = 0, so the integral is zero in this region.
For 0 ≤ x ≤ w, u(x) = 1 and u(w-x) = 1, so we have:
f_W(w) = ∫[0,w] 10e^(-5x-2(w-x)) dx
Evaluating this integral, we get:
f_W(w) = 10e^(-2w) ∫ e^(-3x) dx
= 10e^(-2w) [-1/3 e^(-3x)] from 0 to w
= 10/3 e^(-2w) [1 - e^(-3w)]
For w < 0, u(w-x) = 0, so the integral is zero in this region.
Therefore, the density of the sum W = X + Y is:
fW(w) = { 10/3 e^(-2w) [1 - e^(-3w)] for w ≥ 0
{ 0 for w < 0

1b) Gaussian random variables X and Y have first and second order moments m_{10}=-1.1, m_{20}=1.16, m_{01}=1.5, m_{02} =2.89, R_{XY}=-1.724. Find C_{XY}, ρ.

Ans: To find the covariance (CXY) and correlation coefficient (ρ) of the Gaussian random variables X and Y, we can use the given moments and the formula for covariance.

Given moments:

m10 = E[X] = -1.1
m20 = E[X^2] = 1.16
m01 = E[Y] = 1.5
m02 = E[Y^2] = 2.89
RXY = E [XY] = -1.724

First, we need to find the covariance (CXY):

CXY = E [XY] - E[X] E[Y]
= RXY - m10m01
= -1.724 - (-1.1)(1.5)
= -1.724 + 1.65
= -0.074

Next, we can find the correlation coefficient (ρ):
ρ = CXY / (√ (CXX) * √ (CYY))
Where CXX and CYY are the variances of X and Y, respectively.
We can find the variances using the given moments:
CXX = E[X^2] - (E[X])^2
= m20 - (m10)^2
= 1.16 - (-1.1)^2
= 1.16 - 1.21
= -0.05

CYY = E[Y^2] - (E[Y])^2
= m02 - (m01)^2
= 2.89 - (1.5)^2
= 2.89 - 2.25
= 0.64

Now we can find the correlation coefficient (ρ):

ρ = CXY / (√(CXX) * √(CYY))

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= -0.074 / (√(-0.05) * √(0.64))
= -0.074 / (√(-0.05) * 0.8)

2. a) The auto correlation function for a stationary ergodic process with no periodic components is $R_{XX}(\tau)$=625+(16/1+36 τ2).Find mean and variance of the random process.

Ans: To find the mean (μX) and variance (σX^2) of the random process, we can use the given autocorrelation function (RXX (τ)).

The autocorrelation function is related to the mean and variance by:

RXX (τ) = E[X (t) X(t+τ)]

For a stationary process, the autocorrelation function at τ=0 is equal to the average power:

RXX (0) = E[X^2(t)]

Using the given autocorrelation function:

RXX (0) = 625 + (16/1)
= 625 + 16
= 641

Now, we can find the mean (μX) by using the fact that the autocorrelation function at τ=∞ is equal to the square of the mean:

RXX (∞) = μX^2

As τ approaches infinity, the second term in the autocorrelation function approaches zero:

RXX(∞) = 625

So, the mean (μX) is:

μX = √625
= 25
Now, we can find the variance (σX^2) using the formula:
σX^2 = E[X^2(t)] - μX^2
= RXX(0) - μX^2
= 641 - 25^2
= 641 - 625
= 16
Therefore, the mean (μX) and variance (σX^2) of the random process are:

$\mu X = 25$
$\sigma X^2 = 16$

2b)) Explain about Poisson random processes.

Ans: A Poisson process is a mathematical model that describes the occurrence of events at a fixed average rate, but at random and independently of each other. It's also known as a Poisson point process, Poisson random measure, or Poisson random point field.
Here are some key features of a Poisson process:

- **Events occur independently**

  The arrival of an event is independent of the event before it. This means that the waiting time between events is memory less.

- **Events occur at a constant rate**

  The average time between events is known.

- **Events are counted**

  A Poisson process is an event count, where N(t)

  is the number of events in the interval (0,T)

- **Poisson distribution**

The Poisson distribution is used to calculate the probability of a given number of events occurring in a given interval of time

A Poisson random process, also known as a Poisson point process, is a type of stochastic process that models the occurrence of events over time or space. These events are assumed to occur independently and at a constant average rate.

Here are the key characteristics of a Poisson random process:

1. Independent increments: The number of events occurring in disjoint intervals is independent.
2. Stationarity: The average rate at which events occur is constant over time.
3. Poisson distribution: The number of events occurring in a fixed interval follows a Poisson distribution.

The Poisson distribution is characterized by a single parameter, λ (lambda), which represents the average rate at which events occur. The probability mass function (PMF) of the Poisson distribution is:

P(k) = (e^(-λ) * (λ^k)) / k!

where k is the number of events, e is the base of the natural logarithm, and ! denotes the factorial function.

Some key properties of Poisson random processes include:

Counting process: The number of events occurring up to time t, denoted by N(t), is a Poisson random variable with mean λt.
Interarrival times: The time between consecutive events, denoted by T, follows an exponential distribution with mean 1/λ.
Superposition: The superposition of multiple independent Poisson processes is also a Poisson process.

Poisson random processes have numerous applications in various fields, including:

Telecommunications: Modeling the arrival of phone calls or packets in a network.
Queueing theory: Analyzing the number of customers in a queue.
Biology: Modeling the occurrence of events such as births, deaths, or mutations.
Finance: Modeling the arrival of orders or trades in a financial market.

3. a) A Random signal X(t) of PSD of $N_0/2$ is applied on an LTI system having impulse response h(t). If y(t) is output, find (i)$E[Y^2]$ (ii)$R_{XY}(\tau)$ (iii) $R_{YY}(\tau)$.

Ans: Given:

- X(t) is a random signal with Power Spectral Density (PSD) of N0/2.
- h(t) is the impulse response of an Linear Time-Invariant (LTI) system.
- Y(t) is the output signal.

(i) E[Y^2]:

We know that the average power of the output signal Y(t) is equal to the average power of the input signal X(t) multiplied by the energy of the impulse response h(t).

First, we need to find the energy of the impulse response h(t):

E_h = ∫ |h(t)|^2 dt

Since we don't have an explicit expression for h(t), we'll leave E_h as is for now.

The average power of the input signal X(t) is:

P_X = ∫ (N0/2) df
= N0/2 ∫1.df
= N0/2 (since the integral of 1 over the entire frequency axis is 1)

Now, we can find the average power of the output signal Y(t):

P_Y = E[Y^2] = P_X * E_h
= (N0/2) * E_h

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So, $E[Y^2] = (N0/2) * E_h$.

(ii) $RXY(\tau)$:

The cross-correlation function $RXY(\tau)$ is defined as:

$RXY(\tau) = E[X(t)Y(t+\tau)]$

Using the fact that Y(t) is the output of an LTI system with impulse response h(t), we can write:

$Y(t+\tau) = \int h(\beta)X(t+\tau-\beta)\, d\beta$

Now, we can substitute this expression into the cross-correlation function:

$RXY(\tau) = E[X(t) \int h(\beta)X(t+\tau-\beta)\, d\beta]$
$= \int h(\beta)\, E[X(t)X(t+\tau-\beta)]\, d\beta$
$= \int h(\beta)\, RXX(\tau-\beta)\, d\beta$

where $RXX(\tau)$ is the autocorrelation function of the input signal X(t).

Since X(t) has a PSD of N0/2, its autocorrelation function is:

$RXX(\tau) = (N0/2)\, \delta(\tau)$

where $\delta(\tau)$ is the Dirac delta function.

Now, we can substitute this expression into the cross-correlation function:

$RXY(\tau) = \int h(\beta)\, (N0/2)\, \delta(\tau-\beta)\, d\beta$
$= (N0/2)\, h(\tau)$

So, $RXY(\tau) = (N0/2)\, h(\tau)$.

(iii) $RYY(\tau)$:

The autocorrelation function $RYY(\tau)$ is defined as:

$RYY(\tau) = E[Y(t)Y(t+\tau)]$

Using the fact that Y(t) is the output of an LTI system with impulse response h(t), we can write:

$Y(t) = \int h(\alpha)X(t-\alpha)\, d\alpha$
$Y(t+\tau) = \int h(\beta)X(t+\tau-\beta)\, d\beta$

Now, we can substitute these expressions into the autocorrelation function:

$RYY(\tau) = E[\int h(\alpha)X(t-\alpha)\, d\alpha \int h(\beta)X(t+\tau-\beta)\, d\beta]$
$= \int\int h(\alpha)h(\beta)\, E[X(t-\alpha)X(t+\tau-\beta)]\, d\alpha\, d\beta$

$= \int\int h(\alpha)h(\beta)\, RXX(\tau-\beta+\alpha)\, d\alpha\, d\beta$

Using the expression for $RXX(\tau)$ from part (ii), we get:

$RYY(\tau) = \int\int h(\alpha)h(\beta)\, (N0/2)\, \delta(\tau-\beta+\alpha)\, d\alpha\, d\beta$
$= (N0/2) \int h(\alpha)h(\alpha-\tau)\, d\alpha$

So, $RYY(\tau) = (N0/2) \int h(\alpha)h(\alpha-\tau)\, d\alpha$.

3b) Derive the relationship between Auto-power spectral density and Auto correlation function.

Ans: The relationship between the Auto-Power Spectral Density (APSD) and the Auto-Correlation Function (ACF) is given by the Wiener-Khinchin theorem.

Wiener-Khinchin Theorem:
The Auto-Power Spectral Density (APSD) of a wide-sense stationary (WSS) process X(t) is equal to the Fourier transform of its Auto-Correlation Function (ACF) $RXX(\tau)$:
$SXX(f) = \int RXX(\tau)\, e^{-j2\pi f\tau}\, d\tau$
where SXX(f) is the APSD, $RXX(\tau)$ is the ACF, and f is the frequency.
Inverse Relationship:
The inverse relationship is also true:
$RXX(\tau) = \int SXX(f)\, e^{j2\pi f\tau}\, df$
This means that if we know the APSD SXX(f), we can obtain the ACF $RXX(\tau)$ by taking the inverse Fourier transform.

ASSIGNMENT

. 1. Define conditional probability distribution function and write the properties.

A: Definition:

The Conditional Probability Distribution Function (CPDF) of a random variable Y given X=x is defined as:

$F\_Y|X(y|x) = P(Y \leq y|X=x)$

It represents the probability that Y takes on a value less than or equal to y, given that X has taken on the value x.

Properties of Conditional Probability Distribution Function:

1. Non-Negativity: $F\_Y|X(y|x) \geq 0$ for all y and x.

2. Right-Continuity: $F\_Y|X(y|x)$ is right-continuous in y for all x.

1. Monotonicity: $F\_Y|X(y2|x) - F\_Y|X(y1|x) \geq 0$ for all $y1 < y2$ and x.

2. Boundary Conditions:

- $F\_Y|X(-\infty|x) = 0$ for all x.

- $F\_Y|X(\infty|x) = 1$ for all x.

3. Relationship with Conditional Probability Density Function (CPDF):

- If $F\_Y|X(y|x)$ is differentiable, then the conditional PDF is given by $f\_Y|X(y|x) = \partial F\_Y|X(y|x)/\partial y$.

4. Law of Total Probability:

- $F\_Y(y) = \int_{-\infty}^{\infty} F\_Y|X(y|x)\ f\_X(x)\ dx$.

5. Bayes' Theorem:

- $F\_Y|X(y|x) = F\_X|Y(x|y) * f\_Y(y) / f\_X(x)$.

2. Explain the following with respect to Random processes
   (i) Strict sense stationarity

A: Strict Sense Stationarity (SSS)

A random process $\{X(t), t \in T\}$ is said to be Strict Sense Stationary (SSS) if its probability distribution remains the same for all time shifts.

In other words, the process is SSS if:

$P[X(t1) \leq x1, X(t2) \leq x2, ..., X(tn) \leq xn] = P[X(t1 + \tau) \leq x1, X(t2 + \tau) \leq x2, ..., X(tn + \tau) \leq xn]$

for all n, all time instants t1, t2, ..., tn, all x1, x2, ..., xn, and all time shifts τ.

Implications of SSS:

If a process is SSS, then:

1. The mean and variance of the process are time-invariant.

2. The autocorrelation function of the process depends only on the time difference between the two time instants.

3. The process has the same statistical properties at all times.

Example:

A Gaussian process with a constant mean and variance is an example of an SSS process.

In conclusion, Strict Sense Stationarity is a strong form of stationarity that requires the probability distribution of the process to remain the same for all time shifts.

3.Define Random variable? List out the properties of Density Function

A: Definition of Random Variable

A random variable is a mathematical representation of a variable whose possible values are determined by chance events. It is a function that assigns a numerical value to each outcome of a random experiment.

Properties of Density Function

Here are the properties of a probability density function (PDF) or density function:

1. Non-Negativity: $f(x) \geq 0$ for all x in the domain.
2. Normalization: $\int_{-\infty}^{\infty} f(x)\,dx = 1$.
3. Monotonicity: f(x) is a non-decreasing function.
4. Right-Continuity: f(x) is right-continuous at every point x.
5. Left-Continuity: f(x) is left-continuous at every point x.
6. Integral Property: $P(a \leq X \leq b) = \int_{[a,b]} f(x)\,dx$.
7. Symmetry: If X is a symmetric random variable, then $f(x) = f(-x)$ for all x.
8. Modality: A density function can have one or more modes, which are the values of x that maximize the function.

These properties ensure that a function can be considered a valid probability density function.

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DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

Regulation: R20 **Year: IV-I** **Academic Year: 2023-24**

Subject/Laboratory name: OPTICAL COMMUNICATIONS

Course Instructor(s): K. BABU RAO

MID-1 Question Paper

Time: 02:50 pm to 04:20 pm Date: 20.09.2023 Section: ECE-A&B

Answer the following questions **Max. Marks : 30**

1. a) Give the block diagram of an optical communication system and explain the function of each block?
   b) Give the advantageous and disadvantage of optical fiber communication?
2. a) List the requirements that be satisfied by materials used to manufacture optical fiber?
   b) Write in detail about glass fiber and detail about plastic optical fiber?
3. a) Explain the need of connecter in optical fiber and list out the types of connectors?
   b) Describe the connector return loss in an optical fiber.

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

Regulation: R20 **Year: IV-I** **Academic Year: 2023-24**

Subject/Laboratory name: OPTICAL COMMUNICATIONS

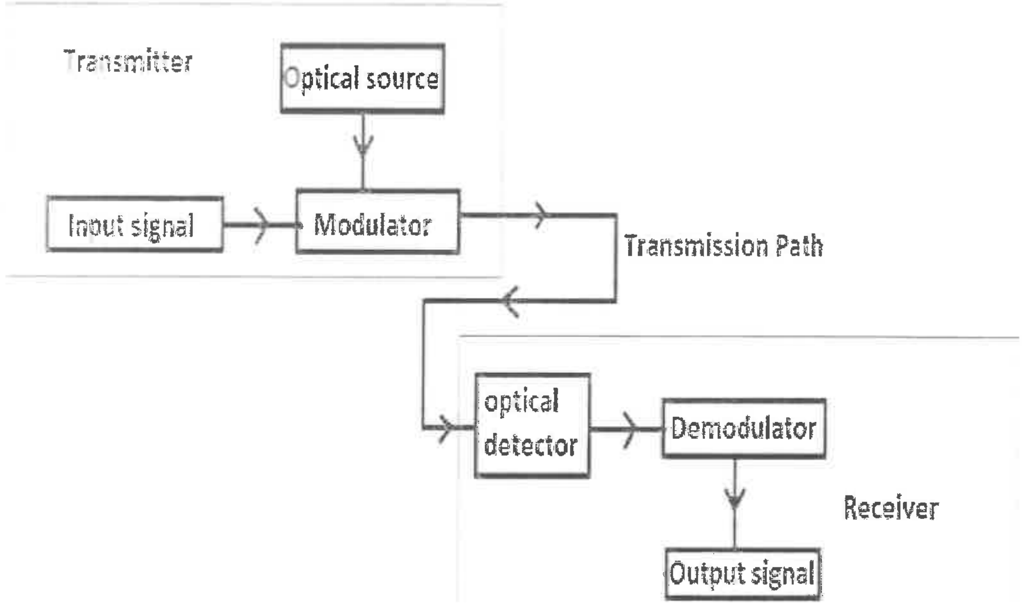
Course Instructor(s): K. BABU RAO

Subject: OC Time: 02:50 pm to 04:20 pm Date: .20.09.2023 Section: ECE-A&B

MID-1 Question Paper Scheme of Valuation with KEY

1.(A) Give the block diagram of an optical communication system and explain the function of each block?

A: A block diagram of an optical communication system shows the major components and their functions in transmitting information:



- **Electro-optical transmitter**: Converts analog or digital information into a modulated beam of light
- **Optical fiber**: Carries the light pulses over long distances
- **Optoelectronic receiver**: Converts the detected light back into an electronic signal

Optical communication systems use light pulses to transmit information over long distances. The light is generated by a laser or light-emitting diode (LED) light source. At the other end of the system, photodiodes detect the light pulses and convert them back into electronic signals.

Optical communication systems are often preferred over electrical cabling because they offer several advantages, including:

- High bandwidth: Optical fibers can transmit large amounts of information.
- Long distance: Optical fibers can transmit information over long distances.

- Electromagnetic interference: Optical fibers are less susceptible to electromagnetic interference than electrical cables.
- Size and weight: Optical fibers are smaller and lighter than copper cables.
- Cost: Optical fibers are generally cheaper than copper cables.

1(b) Give the advantageous and disadvantage of optical fiber communication?

A: Optic Cable Advantages and Disadvantages

Bandwidth. Fiber optic cables have a much greater bandwidth than metal cables. ...

Low Power Loss. An optical fiber offers low power loss, which allows for longer transmission distances. ...

Interference. ...

Size. ...

Weight. ...

Security. ...

Flexibility. ...

Difficult to Splice.

- Less signal degradation: Optical fiber cables experience less signal loss than copper wires.
- High bandwidth: Optical fiber cables have a much greater bandwidth than metal cables.
- Low power loss: Optical fiber offers low power loss, which allows for longer transmission distances.
- Resistance to electromagnetic interference: Fiber optic cables are immune to electromagnetic interference, which is a common issue with copper cables.
- High signal quality: Fiber optic cables provide high-quality signal transmission, reducing the risk of data loss or errors.
- Thinner and lightweight: Fiber optic cables are much thinner and lighter than metal wires.
- Higher carrying capacity: Because optical fibers are much thinner than copper wires, more fibers can be bundled into a given-diameter cable.

2 a) List the requirements that be satisfied by materials used to manufacture optical fiber?

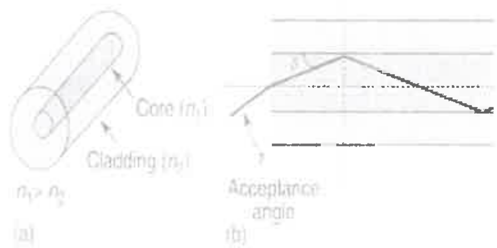
- A: **Transparency**: The material must be transparent for the optical wavelength it's used for.

- **Low attenuation**: The material should have low attenuation of optical signals.
  Refractive index: The core material should have a higher refractive index than the cladding material.
- Light gathering: The material should have a large light gathering capacity.
- Low dispersion: The material should have low dispersion.
- Low loss: The material should be low loss, meaning it doesn't absorb or scatter light.

Optical fibers are usually made from glass, which is almost always silica. However, other materials like fluorozirconate, fluoroaluminate, chalcogenide glasses, and sapphire are also used for specialized applications.

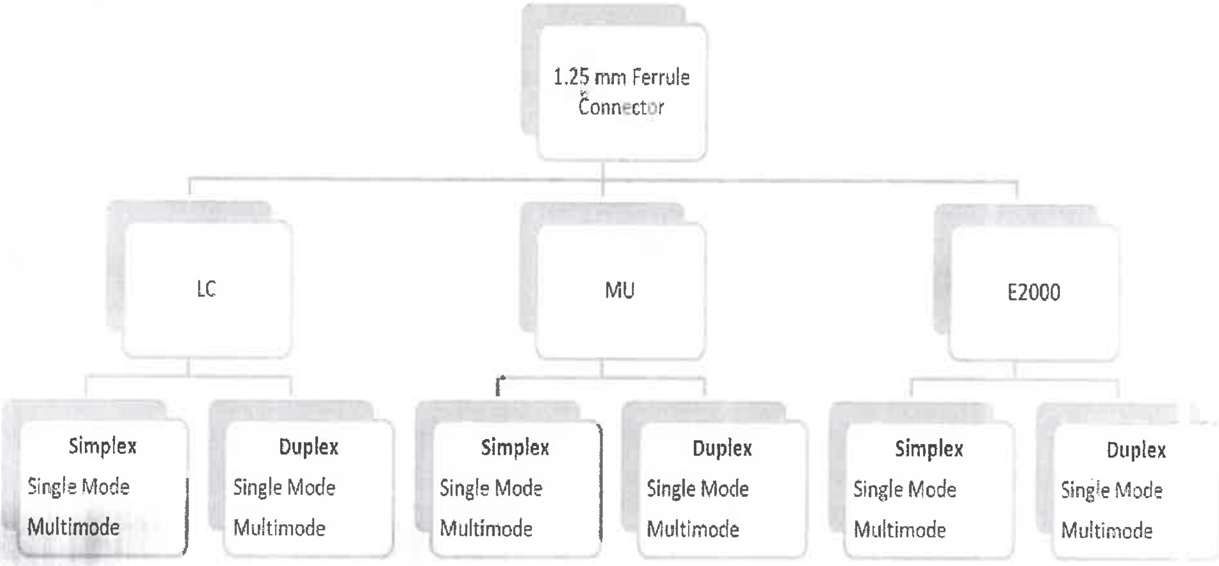
2(b) Write in detail about glass fiber and detail about plastic optical fiber?

A: Glass optical fibers have higher information transmission capacity with lower loss. They are ideal in corrosive environments or extreme temperatures. Plastic optical fibers have great flexibility and are lighter in weight. They can withstand vibration and unstable environments.



3.a) Explain the need of connecter in optical fiber and list out the types of connectors

A: Optical fiber connectors are essential for networking because they link optical fibers and allow light signals to transmit data efficiently. They are important because they:



- **Reduce signal loss**: Well-functioning connectors minimize light loss due to misalignment or reflection
- **Increase data transfer speeds**: Connectors help maintain high data transfer speeds
- **Enable quick connections:** Connectors allow for quicker connections and disconnections than splicing

There are many different types of optical fiber connectors, including:

- **LC**

A compact, high-performance connector that's easy to use. It's often used for high-density deployments where multiple fibers terminate in a small space.

- **SC**

A low-cost, durable, and simple connector that's used with single-mode and multimode fiber-optic cables. It features ceramic ferrules for accurate alignment.

3b) Describe the connector return loss in an optical fiber.

A: Connector return loss (ORL) in an optical fiber is the amount of light that reflects back to the source due to a mismatch between the connector and the fiber. It's measured in decibels (dB) and is usually a negative number. A high return loss is good because it indicates that the connector is minimizing reflections and matching the fiber.

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

Regulation: R20 **Year: IV-I** **Academic Year: 2023-24**

Subject/Laboratory name: OPTICAL COMMUNICATIONS

Course Instructor(s): K. BABU RAO

MID-2 Question Paper

Time: 02:50 pm to 04:20 pm Date: 05.12.2023 Section: ECE-A&B

Answer the following questions **Max. Marks : 30**

1. What is meant by 'fiber splicing'? Explain various types of fiber splicing techniques and fiber connectors.
2. a) Explain the working principle of edge emitting and surface emitting double hetero junction LED?
   b) Explain the Physical principles of PIN and APD with neat diagrams?
3. Explain about link power budget and rise time budget in optical communication system.

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DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

Regulation: R20 **Year: IV-I** **Academic Year: 2023-24**

Subject/Laboratory name: OPTICAL COMMUNICATIONS

Course Instructor(s): K.BABU RAO

MID-2 Question Paper scheme of evaluation

Time: 02:50 pm to 04:20 pm Date: 05.12.2023 Section: ECE-A&B

Scheme of evaluation with KEY

1.What is meant by 'fiber splicing'? Explain various types of fiber splicing techniques and fiber connectors?

A: Fiber splicing is the process of permanently joining two fiber optic cables together to create a single functioning cable. The two most common types of fiber splicing are mechanical and fusion:

- **Mechanical splicing**

Involves aligning and holding the fibers together with a mechanical mechanism and index matching fluid. Mechanical splicing is often used for emergency repairs and fiber testing.

- **Fusion splicing**

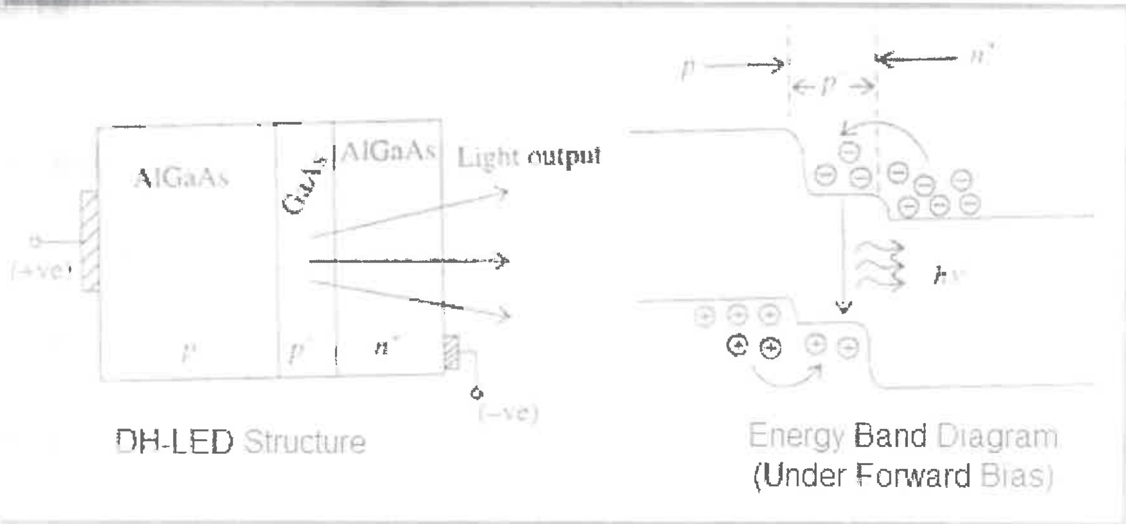
Involves using an electric arc, carbon dioxide (CO2) laser, or gas flame to melt the ends of the fibers together. Fusion splicing is the most common method because it produces the most reliable joint with the lowest insertion loss and almost no back reflection.

Fiber connectors, also known as terminations, are devices that connect two fiber optic cables together. They are faster to connect and disconnect than splicing. There are many types of fiber connectors, including SC, LC, ST, and MTP, each designed for a specific application.

2. a) Explain the working principle of edge emitting and surface emitting double hetero junction LED?

A: he working principles of edge-emitting and surface-emitting double heterojunction LEDs are as follows:

- Edge-emitting LEDs



Light is emitted from the edge of the LED, where the active region meets the cleaved surface. This is done to reduce losses and make the beam more directional. The light propagates parallel to the wafer surface of the semiconductor chip.

Surface-emitting LEDs

Light propagates in the direction perpendicular to the semiconductor wafer surface.

Double heterojunctions are formed when a layer of material with a particular bandgap energy is sandwiched between layers of material with a higher energy bandgap. This forms a barrier that restricts the region of electron-hole recombination to the lower bandgap material.

Here are some more details about how ELEDs and SLEDs work:

ELEDs

ELEDs have two guiding layers with a lower refractive index than the active region, but a higher refractive index than the surrounding material. This creates a waveguide channel that directs optical radiation into the fiber.

Optical guidance

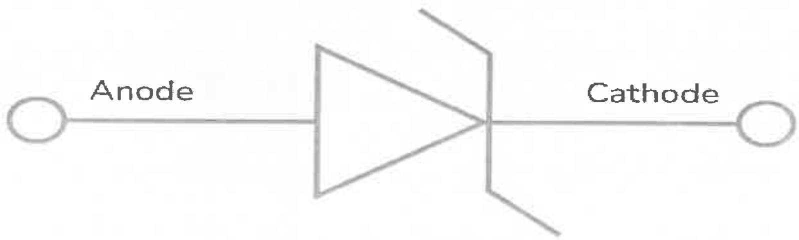
The optical guidance of emitted radiation in ELEDs results in a low divergence output beam, typically around 30° in the vertical direction. This increases the efficiency of coupling the LED with an optical fiber.

Beam quality

The light emitted by LEDs has low spatial coherence and focusability, compared to laser diodes.

2b) Explain the Physical principles of PIN and APD with neat diagrams?

APD Symbol



A; PIN and avalanche photodiodes (APDs) are both types of photodetectors that convert optical power into photocurrent. They differ in their construction, sensitivity, and cost, as described below:

- **PIN diode**

A PIN diode has three layers: a P-type layer, an intrinsic layer, and an N-type layer. The intrinsic layer is made of undoped semiconductor material and has a very low doping level. The PIN diode operates under high-level injection, where charge carriers from the P and N regions flood the intrinsic layer. PIN diodes are reliable and cost-effective, and are used in a variety of devices, including attenuators, photodetectors, and fast switches.

- **Avalanche photodiode**

APDs have higher sensitivity than PIN diodes because they have more layers and a smaller depletion region. APDs are best suited for high-speed, long-haul communications, but they are more expensive than PIN diodes.
APDs work by applying a high electric field to the thick intrinsic region, which causes secondary ionization and a dramatic increase in the number of electrons and holes.

3.Explain about link power budget and rise time budget in optical communication system.

A:In an optical communication system, the link power budget and rise time budget are two important analyses that determine the performance of a fiber link:

- **Link power budget**

Determines if the receiver has enough power to achieve the desired signal quality. It's calculated by allocating the available optical power among various loss-producing mechanisms, such as fiber attenuation, splice losses, and connector losses.

ASSIGNMENT

1. Define Graded Index fiber (GIF). Explain the ray transmission mechanism in GIF.

A: Definition of Graded Index Fiber (GIF)

A Graded Index Fiber (GIF) is a type of optical fiber that has a core with a refractive index that decreases gradually as the radial distance from the center of the core increases. This gradual decrease in refractive index is called a "graded index" profile.

Ray Transmission Mechanism in GIF:

In a Graded Index Fiber, the ray transmission mechanism is based on the principle of total internal reflection. Here's how it works:

1. Light Entry: When light enters the GIF, it is refracted, or bent, as it passes from the air into the core.

2. Refraction: As the light travels through the core, it encounters a gradual decrease in refractive index. This causes the light to be refracted, or bent, towards the center of the core.

3. Total Internal Reflection: When the light reaches the cladding, which has a lower refractive index than the core, it is totally internally reflected back into the core.

4. Ray Bending: As the light continues to travel through the core, it is continuously refracted, or bent, due to the graded index profile. This bending causes the light to follow a curved path through the core.

5. Signal Transmission: The graded index profile of the GIF allows multiple light signals to be transmitted through the fiber with minimal dispersion, or spreading, of the signals.

The graded index profile of the GIF reduces modal dispersion, which is the spreading of light signals due to the different paths they take through the fiber. This reduction in modal dispersion allows GIFs to transmit signals over longer distances with higher bandwidths.

2. Define the term dispersion in fibers. Discuss about Material dispersion?

A: Dispersion in fibers refers to the spreading of light signals as they travel through the fiber. This spreading can cause the signal to become distorted, leading to errors in data transmission.

Types of Dispersion in Fibers

There are two main types of dispersion in fibers:

1. Modal Dispersion (or Intermodal Dispersion)

2. Chromatic Dispersion

Chromatic Dispersion

Chromatic dispersion occurs because different wavelengths of light travel at different speeds through the fiber. There are two types of chromatic dispersion:

1. Material Dispersion

2. Waveguide Dispersion

Material Dispersion

Material dispersion occurs because the refractive index of the fiber material varies with wavelength. This variation causes different wavelengths of light to travel at different speeds through the fiber.

Material dispersion is caused by the following factors:

1. Variation in refractive index: The refractive index of the fiber material decreases as the wavelength increases.
2. Absorption: The fiber material absorbs certain wavelengths of light, causing them to travel slower.
3. Scattering: The fiber material scatters certain wavelengths of light, causing them to travel slower.

Material dispersion can be quantified using the material dispersion parameter (Dm), which is typically measured in units of picoseconds per kilometer per nanometer (ps/km/nm).

To minimize material dispersion, fiber manufacturers use various techniques, such as:

1. Using materials with low dispersion: Some materials, like silica, have lower dispersion than others.
2. Designing fibers with optimized refractive index profiles: By carefully designing the refractive index profile of the fiber, manufacturers can reduce material dispersion.
3. Using dispersion-compensating fibers: These fibers are designed to have negative dispersion, which can be used to compensate for the positive dispersion of other fibers.

3. What is WDM? Explain the basic principle of WDM?

A: WDM stands for Wavelength Division Multiplexing. It's a technology used in optical communication systems to multiplex multiple signals onto a single optical fiber by using different wavelengths.

Basic Principle of WDM:

The basic principle of WDM is to divide the available optical bandwidth into multiple channels, each operating at a different wavelength. This allows multiple signals to be transmitted simultaneously over a single optical fiber.

Here's how it works:

1. Signal Generation: Multiple signals are generated at different wavelengths using lasers or light-emitting diodes (LEDs).
2. Multiplexing: The signals are multiplexed onto a single optical fiber using a multiplexer.
3. Transmission: The multiplexed signal is transmitted over the optical fiber.
4. Demultiplexing: At the receiving end, the signal is demultiplexed using a demultiplexer, which separates the signals based on their wavelengths.
5. Detection: The individual signals are detected using photodetectors.

WDM offers several benefits, including:

- Increased bandwidth
- Improved spectral efficiency

- Reduced interference
- Enhanced scalability

WDM is widely used in modern optical communication systems, including long-haul networks, metropolitan area networks, and data center interconnects.

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2.5.2. Mechanism to deal with internal examination related grievances is transparent, time- bound and efficient

Subject: ML Time: 03:00 pm to 04:30 pm Date: 13-04-2023 Section: CSE

Answer the following questions Max. Marks: 30

1.a) Explain about machine learning

b).Explain the types of learning.

2.a) Explain K-ns algorithm

b).Explain clustering in machine learning.

3.a) Explain neural network.

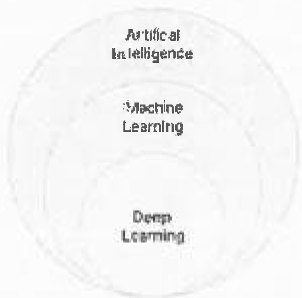
b).Implementing MLP's with kera's

Course instructor: Dr.M.Veera Kumari

MID-I Question paper Scheme of Valuation

1.a) Explain about machine learning

Machine learning is a branch of artificial intelligence (AI) and computer science which focuses on the use of data and algorithms to imitate the way that humans learn, gradually improving its accuracy. IBM has a rich history with machine learning.



b). Explain the types of learning

Types of Machine Learning:

There are several types of machine learning, each with special characteristics and applications. Some of the main types of machine learning algorithms are as follows:

1.supervised learning
2.unsupervised learning
3.semi supervised learning
4.reinforcement learning

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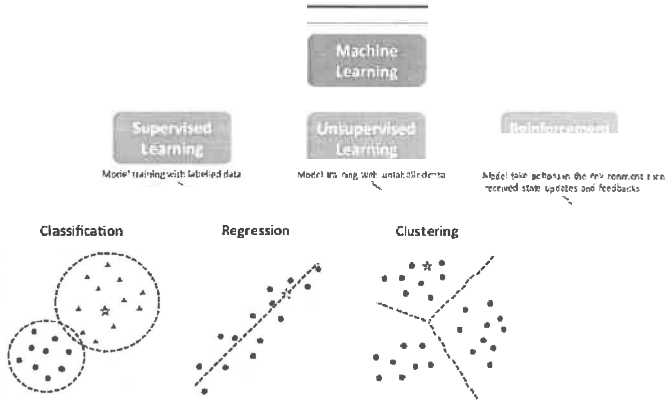


1. Supervised Machine Learning

Supervised learning is defined as when a model gets trained on a **"Labelled Dataset"**. Labelled datasets have both input and output parameters. In **Supervised Learning** algorithms learn to map points between inputs and correct outputs. It has both training and validation datasets labelled.

2. Unsupervised Machine Learning

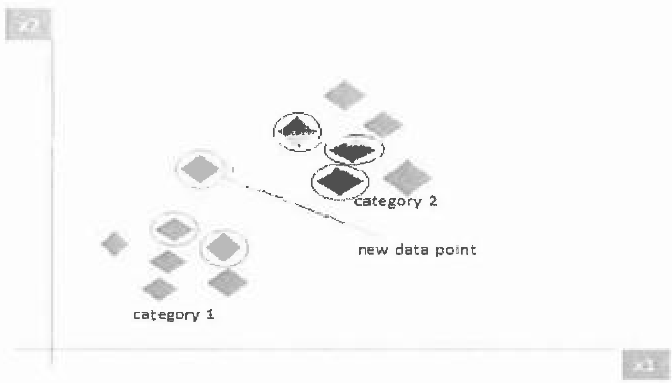
Unsupervised Learning Unsupervised learning is a type of machine learning technique in which an algorithm discovers patterns and relationships using unlabeled data. Unlike supervised learning, unsupervised learning doesn't involve providing the algorithm with labeled target outputs. The primary goal of Unsupervised learning is often to discover hidden patterns, similarities, or clusters within the data, which can then be used for various purposes, such as data exploration, visualization, dimensionality reduction, and more.

3. Reinforcement Machine Learning

Reinforcement machine learning algorithm is a learning method that interacts with the environment by producing actions and discovering errors. **Trial, error, and delay** are the most relevant characteristics of reinforcement learning. In this technique, the model keeps on increasing its performance using Reward Feedback to learn the behavior or pattern. These algorithms are specific to a particular problem e.g. Google Self Driving car, AlphaGo where a bot competes with humans and even itself to get better and better performers in Go Game. Each time we feed in data, they learn and add the data to their knowledge which is training data. So, the more it learns the better it gets trained and hence experienced.

2.a)Explain KNN algorithm

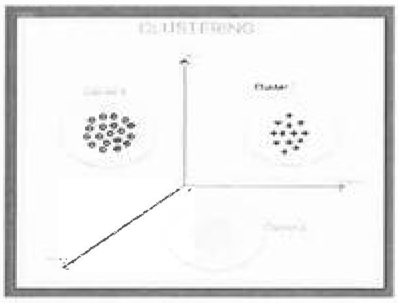
K-Nearest Neighbours is one of the most basic yet essential classification algorithms in Machine Learning. It belongs to the supervised learning domain and finds intense application in pattern recognition, data mining, and intrusion detection.
It is widely disposable in real-life scenarios since it is non-parametric, meaning, it does not make any underlying assumptions about the distribution of data (as opposed to other algorithms such as GMM, which assume a Gaussian distribution of the given data).



Now, given another set of data points (also called testing data), allocate these points to a group by analyzing the training set. Note that the unclassified points are marked as 'White'.

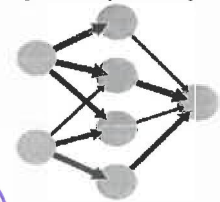
b) Explain clustering in machine learning

Clustering is an unsupervised machine learning task. You might also hear this referred to as cluster analysis because of the way this method works. Using a clustering algorithm means you're going to give the algorithm a lot of input data with no labels and let it find any groupings in the data it can



3.a) Explain neural network

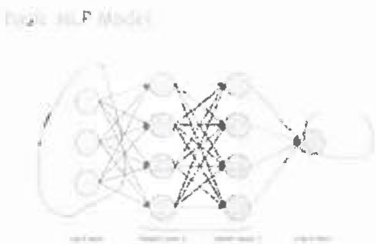
A neural network is a method in artificial intelligence that teaches computers to process data in a way that is inspired by the human brain. It is a type of machine learning process, called deep learning, that uses interconnected nodes or neurons in a layered structure that resembles the human brain



b) Implementing MLP's with kera's

The basic components of the perceptron include Inputs, Weights and Biases, Linear combination, and Activation function. Following is the basic terminology of each of the components.

1. Inputs of a perceptron are real values input
2. Weights are parameters within the neural network to transform input data.
3. Bias is an additional parameter used to adjust output along with a weighted sum.
4. Linear combination is the merging of input values.
5. Activation values are non-linear transformations of input for specific outputs. To understand this further, we are going to implement a classification task on the MNIST dataset of handwritten digits using Keras deep learning module.



MID-II Question paper Scheme of Valuation

1.a) Explain Ensemble learning

b) Explain voting classifiers

2.a) Explain bagging and pasting

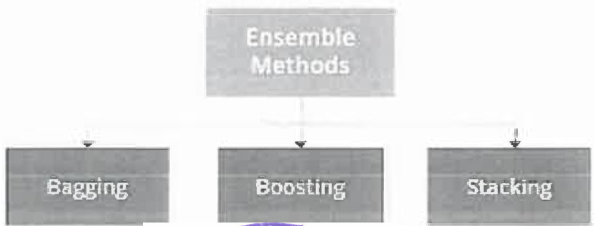
b) Explain random forests

3.a) Explain linear SVM Classification

b) Explain naïve bayes Classification

1.a) Explain Ensemble learning

Ensemble learning is an approach in which two or more models are fitted to the same data, and the predictions of each model are combined. Ensemble learning aims to achieve better performance with the ensemble of models than with any individual model.

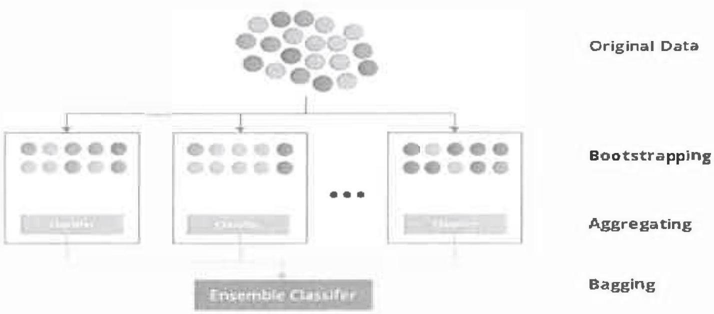


b) Explain voting classifiers

The voting classifier is an ensemble learning method that combines several base models to produce the final optimum solution. The base model can independently use different algorithms such as KNN, Random forests, Regression, etc., to predict individual outputs. This brings diversity in the output, thus called Heterogeneous ensembling. In contrast, if base models use the same algorithm to predict separate outcomes, this is called Homogeneous ensembling.

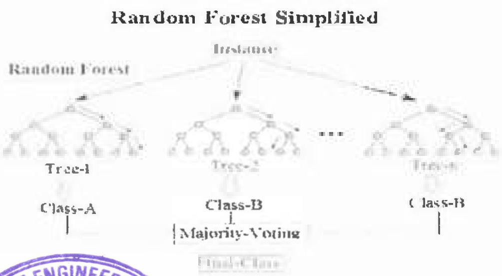
2.a) Explain bagging and pasting

There are several ways to group models. They differ in the training algorithm and data used in each one of them and also how they are grouped.
We'll be talking in the article about two methods called **Bagging** and **Pasting** and how to implement them in scikit-learn



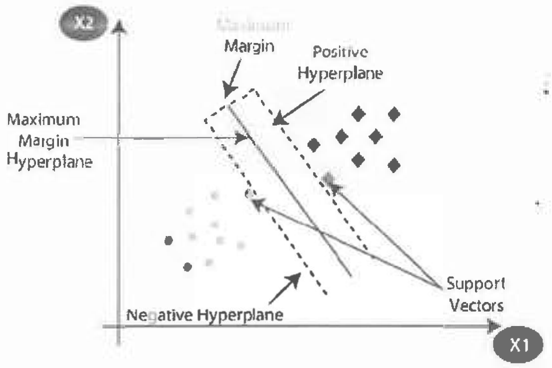
b) Explain random forests

Random forest produces multiple decision trees, randomly choosing features to make decisions when splitting nodes to create each tree. It then takes these randomized observations from each tree and averages them out to build a final model.



3.a) Explain linear SVM Classification

Linear SVM: Linear SVM is used for linearly separable data, which means if a dataset can be classified into two classes by using a single straight line, then such data is termed as linearly separable data, and classifier is used called as Linear SVM classifier.



b) Explain naïve bayes Classification

The naive Bayes classifier can be used to determine the probabilities of the classes given a number of different observations. The assumption in the model is that the feature variables are conditionally independent given the class we will not discuss the meaning of conditional independence in this course

The "Naive" part of the name indicates the simplifying assumption made by the Naïve Bayes classifier. The classifier assumes that the features used to describe an observation are conditionally independent, given the class label. The "Bayes" part of the name refers to Reverend Thomas Bayes, an 18th-century statistician and theologian who formulated Bayes' theorem.

Bayes' Theorem finds the probability of an event occurring given the probability of another event that has already occurred. Bayes' theorem is stated mathematically as the following equation:

Where A and B are events and P (B) $\neq 0$

1. Basically, we are trying to find probability of event A; given the event B is true. Event B is also termed as **evidence**.
2. P (A) is the **priori** of A (the prior probability, i.e. Probability of event before evidence is seen). The evidence is an attribute value of an unknown instance (here, it is event B).
3. P (B) is Marginal Probability: Probability of Evidence.
4. P (A|B) is a posteriori probability of B, i.e. probability of event after evidence is seen.
5. P (B|A) is Likelihood probability i.e. the likelihood that a hypothesis will come true based on the evidence.

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2.5.2. Mechanism to deal with internal examination related grievances is transparent, time- bound and efficient

Subject: DAA Time: 03:00 pm to 04:30 pm Date: 13.04.2022 Section: CSE

Answer the following questions Max. Marks: 30

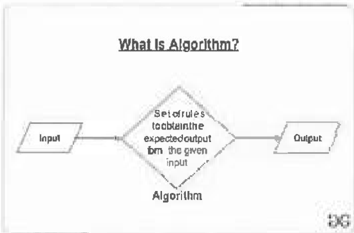
1. a) **Define Algorithm in Design analysis**
   b) **Explain asymptotic notation in design analysis.**
2. a) **Explain Binary search.**
   b) **Explain general method**
3. a) **Explain quick sort in Design analysis.**
   b) **Explain minimum cost spanning tree**

Course instructor: k.Paul chinnaiah

MID-I Question paper Scheme of Valuation

1.a) **Define Algorithm in Design analysis.**

Algorithm: Algorithms are step-by-step procedures designed to solve specific problems and perform tasks efficiently in the realm of computer science and mathematics. These powerful sets of instructions form the backbone of modern technology and govern everything from web searches to artificial intelligence. The best way to understand an algorithm is to think of it as a recipe that guides you through a series of well-defined actions to achieve a specific goal. Just like a recipe produces a replicable result, algorithms ensure consistent and reliable outcomes for a wide range of tasks in the digital realm.



b) **Explain asymptotic notation in design analysis.**

Asymptotic notation: An asymptotic notation essentially describes the running time of an algorithm. This means that it shows how much time the algorithm takes to run with a given input, n. There are three different notations, big O, big Theta (θ), and big Omega (Ω).Big O is used for the worst-case running time, big θ is used when the running time is the same for all cases, and big Ω is used for the best case running time

The order of growth of the running time of an algorithm gives a simple character of the algorithm's efficiency and also allows allow us to compare relative performance of alternative algorithm. we call it growth function as we ignore the very small constant. The asymptotic running time of an algorithm is defined in terms of functions

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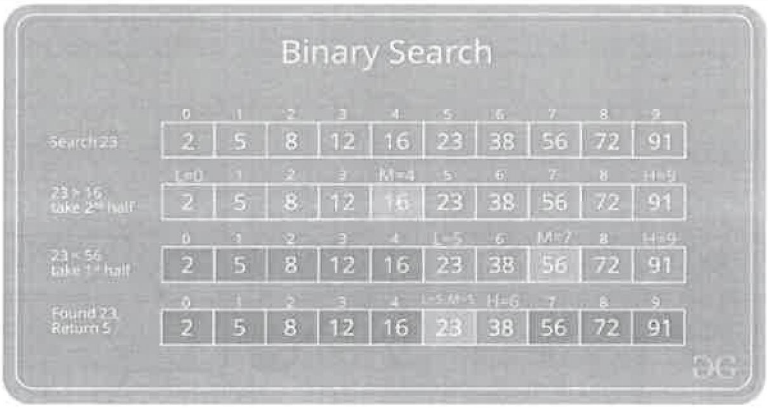
2.a) Explain Binary search.

Binary Search: Binary search is an efficient algorithm for finding an item from a sorted list of items. It works by **repeatedly** dividing in half the portion of the list that could contain the item, until you've narrowed down the possible locations to just one. We used binary search in the One of the most common ways to use binary search is to find an item in an array.

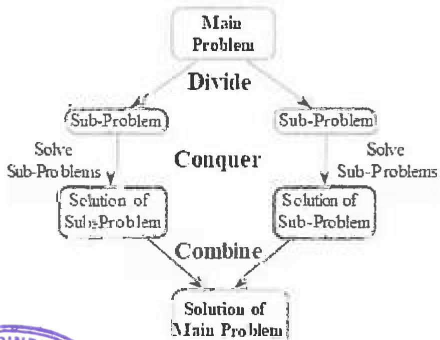
For example, the Tycho-2 star catalog contains information about the brightest 2,539,913 stars in our galaxy. Suppose that you want to search the catalog for a particular star, based on the star's name. If the program examined every star in the star catalog in order starting with the first, an algorithm called linear search, the computer might have to examine all 2,539,913 stars to find the star you were looking for, in the worst case. If the catalog were sorted alphabetically by star names, binary search would not have to examine more than 22 stars, even in the worst case. Guessing game in the introductory tutorial.



b) **Explain general method**

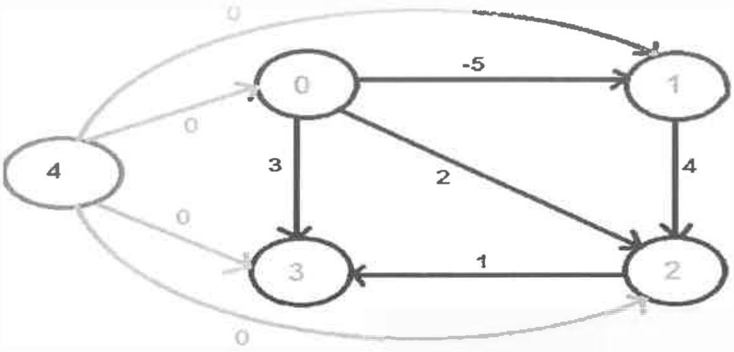
General method: The General Methods aim to describe the Institute's procedures in a general manner. What specific individual steps the Institute undertakes in the assessment of specific medical interventions depend, among other things, on the research question posed and the available scientific evidence. Methods should therefore be regarded as a kind of framework. How the assessment process is designed in individual cases is presented in detail for each specific project.

The Institute's methods are usually reviewed annually with regard to any necessary revisions, unless errors in the document or relevant developments necessitate prior updating. Project-specific methods are defined on the basis of the methods version valid at that time



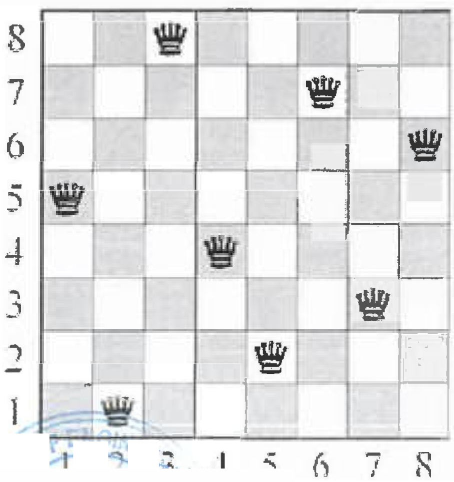
1. History and explanation: Some pairs of nodes might not be reachable between each other, so no shortest path exists between these pairs. In this scenario, the algorithm will return Infinity value as a result between these pairs of nodes.GDS includes functions such as gds.util.isFinite to help filter infinity values from results. Starting with Neo4j 5, the Infinity literal is now included in Cypher too.

2. Use-cases - when to use the All Pairs Shortest Path algorithm: The All Pairs Shortest Path algorithm is used in urban service system problems, such as the location of urban facilities or the distribution or delivery of goods. One example of this is determining the traffic load expected on different segments of a transportation grid. For more information, see Urban Operations Research.



3.a)Explain 8 Queen problem:

The eight queens puzzle is the problem of placing eight chess queens on an 8×8 chessboard so that no two queens threaten each other; thus, a solution requires that no two queens share the same row, column, or diagonal. There are 92 solutions. The problem was first posed in the mid-19th century.The eight queens puzzle is a special case of the more general n queens problem of placing n non-attacking queens on an nxn chessboard. Solutions exist for all natural numbers n with the exception of n = 2 and n = 3. Although the exact number of solutions is only known for n ≤ 27, the asymptotic growth rate of the number of solutions is approximately (0.143 n)n.



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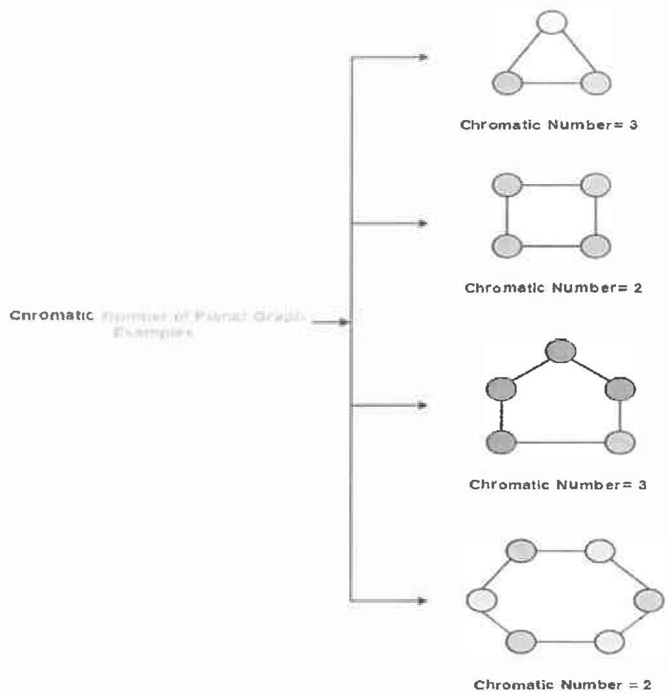
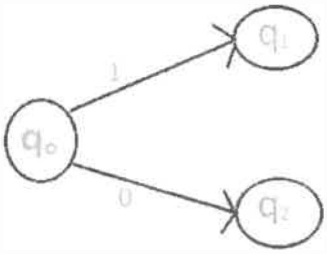
b) Define graph coloring:

A graph coloring is an assignment of labels, called colors, to the vertices of a graph such that no two adjacent vertices share the same color. The chromatic number χ(G) of a graph G is the minimal number of colors for which such an assignment is possible.The study of graph colorings has historically been linked closely to that of planar graphs and the four color theorem, which is also the most famous graph coloring problem. That problem provided the original motivation for the development of algebraic graph theory and the study of graph invariants such as those discussed on this page. In modern times, many open problems in algebraic graph theory deal with the relation between chromatic polynomials and their graphs. Applications for solved problems have been found in areas such as computer science, information theory, and complexity theory

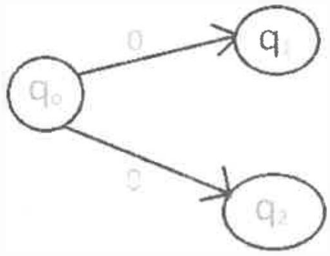


3.a)Explain non-deterministic algorithm:

In computer programming, a nondeterministic algorithm is an algorithm that, even for the same input, can exhibit different behaviors on different runs, as opposed to a deterministic algorithm. There are several ways an algorithm may behave differently from run to run.A concurrent algorithm can perform differently on different runs due to a race condition. A probabilistic algorithm's behaviors depends on a random number generator. An algorithm that solves a problem in nondeterministic polynomial time can run in polynomial time or exponential time depending on the choices it makes during execution. The nondeterministic algorithms are often used to find an approximation to a solution, when the exact solution would be too costly to obtain using a deterministic one.



Deterministic Algorithm

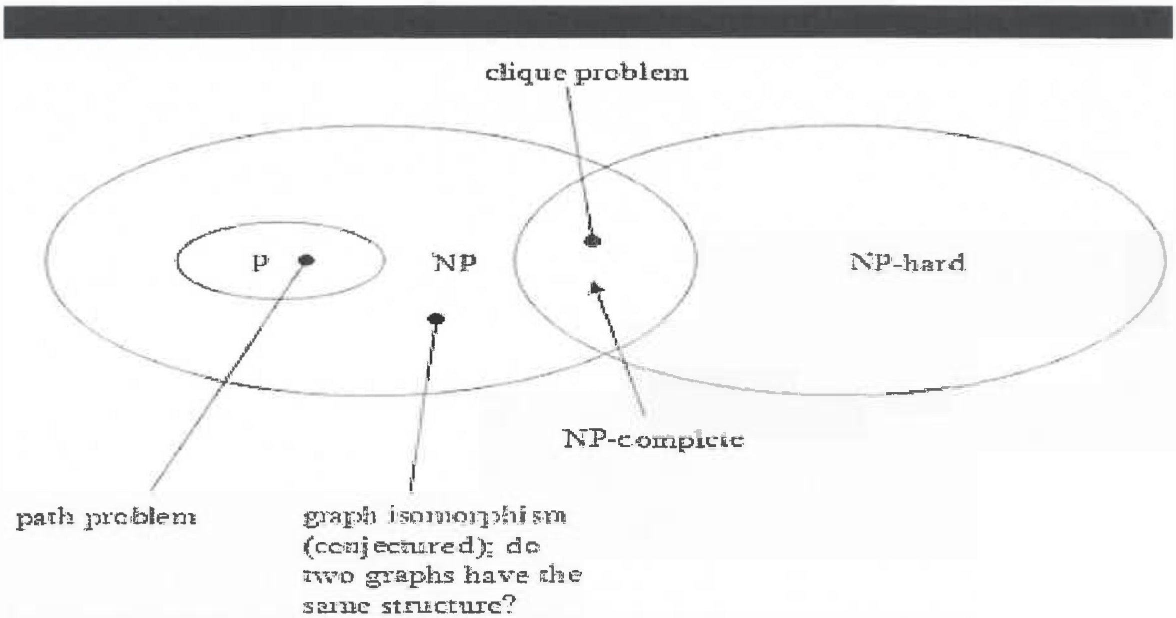


Non-Deterministic Algorithm

b) Explain coook's theorem:

In computational complexity theory, the Cook–Levin theorem, also known as Cook's theorem, states that the Boolean satisfiability problem is NP-complete. That is, it is in NP, and any problem in NP can be reduced in polynomial time by a deterministic Turing machine to the Boolean satisfiability problem.

An important consequence of this theorem is that if there exists a deterministic polynomial-time algorithm for solving Boolean satisfiability, then every NP problem can be solved by a deterministic polynomial-time algorithm. The question of whether such an algorithm for Boolean satisfiability exists is thus equivalent to the P versus NP problem, which is still widely considered the most important unsolved problem in theoretical computer science as of 2023.



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III B.Tech I Sem (R20) MID - 1 EXAMINATION

Subject:RS&GIS CIVIL **Time : 10:00 am to 11:30 am** **Date :** **Section :**

Answer the following questions **Max. Marks : 30**

1.Explain what is electro magnetic spectrum

2. What is visual interpretation and explain it's elements.

3. a) What is GIS and Explain it's terminology.

b) Write about key component's of GIS.

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III B.Tech I Sem (R20) MID - 1 EXAMINATION

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CIVIL

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III B.Tech I Sem (R20) MID - 1 EXAMINATION

Subject:RS&GIS Time : 10:00 am to 11:30 am Date : Section : CIVIL

MID -1 QUESTIONS WITH ANSWERS

1.Explain what is electro magnetic spectrum

n remote sensing, some parameters of the target are measured without being in touch with it. To measure any parameters using remotely located sensors, some processes which convey those parameters to the sensor are required. A best example is the natural remote sensing by which we are able to see the objects around us and to identify their properties. We are able to see the objects around us when the solar light hits them and gets reflected and captured in our eyes. We are able to identify the properties of the objects when these signals captured in our eyes are transferred to the brain and are analyzed. The whole process is analogous to the manmade remote sensing techniques.

In remote sensing techniques, electromagnetic radiation emitted / reflected by the targets are recorded at remotely located sensors and these signals are analyzed to interpret the target characteristics. Characteristics of the signals recorded at the sensor depend on the characteristics of the source of radiation / energy, characteristics of the target and the atmospheric interactions.

This following gives details of the electromagnetic spectrum. Details of the energy sources and the radiation principles are also covered in this lecture.

2. Electromagnetic energy

Electromagnetic (EM) energy includes all energy moving in a harmonic sinusoidal wave pattern with a velocity equal to that of light. Harmonic pattern means waves occurring at frequent intervals of time.

Electromagnetic energy has both electric and magnetic components which oscillate perpendicular to each other and also perpendicular to the direction of energy propagation as shown in Fig. 1.

It can be detected only through its interaction with matter.

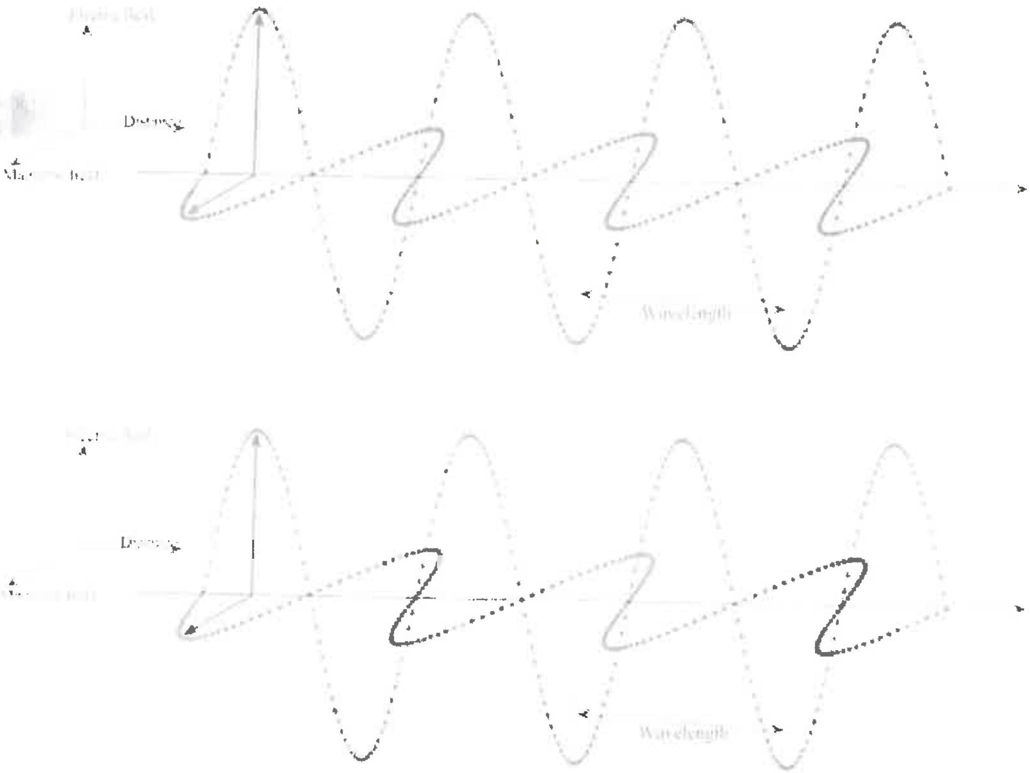

Fig.1. Electromagnetic wave

Examples of different forms of electromagnetic energy: Light, heat etc.

EM energy can be described in terms of its velocity, wavelength and frequency.

All EM waves travel at the speed of light, c, which is approximately equal to 3×10^{8} m/s.

Wavelength λ of an EM wave is the distance from any point on one wave to the same position on the next wave (e.g., distance between two successive peaks). The wavelengths commonly used in remote sensing are very small. It is normally expressed in micrometers (µm). 1 µm is equal to 1×10^{-6} m.

Frequency f is the number of waves passing a fixed point per unit time. It is expressed in Hertz (Hz).

The three attributes are related by

$$c = \lambda f \qquad (1)$$

which implies that wavelength and frequency are inversely related since c is a constant. Longer wavelengths have smaller frequency compared to shorter wavelengths.

Engineers use frequency attributes to indicate radio and radar regions. However, in remote sensing EM waves are categorized in terms of their wavelength location in the EMR spectrum.

Another important theory about the electromagnetic radiation is the particle theory, which suggests that electromagnetic radiation is composed of discrete units called photons or quanta.

Electromagnetic radiation spectrum

The EM spectrum ranges from gamma rays with very short wavelengths to radio waves with very long wavelengths. The EM spectrum is shown in a logarithmic scale in order to portray shorter wavelengths.

The visible region (human eye is sensitive to this region) occupies a very small region in the range between 0.4 and 0.7 µm. The approximate range of color "blue" is 0.4 – 0.5 µm, "green" is 0.5-0.6 µm and "red" is 0.6-0.7 µm. Ultraviolet (UV) region adjoins the blue end of the visible region and infrared (IR) region adjoins the red end.

The infrared (IR) region, spanning between 0.7 and 100 µm, has four subintervals of special interest for remote sensing:

(1) Reflected IR (0.7 – 3.0 µm)

(2) Film responsive subset, the photographic IR (0.7 – 0.9 µm)

(3) and (4) Thermal bands at (3 – 5 µm) and (8 – 14 µm).

Longer wavelength intervals beyond this region are referred to in units ranging from 0.1 to 100 cm. The microwave region spreads across 0.1 to 100 cm, which includes all the intervals used by radar systems. The radar systems generate their own active radiation and direct it towards the targets of interest. The details of various regions and the corresponding wavelengths are given

n remote sensing, some parameters of the target are measured without being in touch with it. To measure any parameters using remotely located sensors, some processes which convey those parameters to the sensor are required. A best example is the natural remote sensing by which we are able to see the objects around us and to identify their properties. We are able to see the objects around us when the solar light hits them and gets reflected and captured in our eyes. We are able to identify the properties of the objects when these signals captured in our eyes are transferred to the brain and are analyzed. The whole process is analogous to the manmade remote sensing techniques.

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This following gives details of the electromagnetic spectrum. Details of the energy sources and the radiation principles are also covered in this lecture.

2. What is visual interpretation and explain it's elements.

As we noted in the previous section, analysis of remote sensing imagery involves the identification of various targets in an image, and those targets may be environmental or artificial features which consist of points, lines, or areas. Targets may be defined in terms of the way they reflect or emit radiation. This radiation is measured and recorded by a sensor, and ultimately is depicted as an image product such as an air photo or a satellite image.

What makes interpretation of imagery more difficult than the everyday visual interpretation of our surroundings? For one, we lose our sense of depth when viewing a two-dimensional image, unless we can view it **stereoscopically** so as to simulate the third dimension of height. Indeed, interpretation benefits greatly in many applications when images are viewed in stereo, as visualization (and therefore, recognition) of targets is enhanced dramatically. Viewing objects from directly above also provides a very different perspective than what we are familiar with. Combining an unfamiliar perspective with a very different scale and lack of recognizable detail can make even the most familiar object unrecognizable in an image. Finally, we are used to seeing only the visible wavelengths, and the imaging of wavelengths outside of this window is more difficult for us to comprehend.

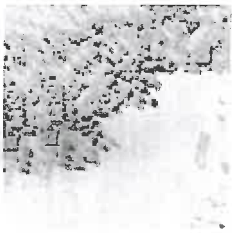
Recognizing targets is the key to interpretation and information extraction. Observing the differences between targets and their backgrounds involves comparing different targets based on any, or all, of the visual elements of **tone, shape, size, pattern, texture, shadow, and association**. Visual interpretation using these elements is often a part of our daily lives, whether we are conscious of it or not. Examining satellite images on the weather report, or following high speed chases by views from a helicopter are all familiar examples of visual image interpretation. Identifying targets in remotely sensed images based on these visual elements allows us to further interpret and analyze. The nature of each of these interpretation elements is described below, along with an image example of each.

Tone refers to the relative brightness or colour of objects in an image. Generally, tone is the fundamental element for distinguishing between different targets or features. Variations in tone also allows the elements of shape, texture, and pattern of objects to be distinguished.

Shape refers to the general form, structure, or outline of individual objects. Shape can be a very distinctive clue for interpretation. Straight edge shapes typically represent urban or agricultural (field) targets, while natural features, such as forest edges, are generally more irregular in shape, except where man has created a road or clear cuts. Farm or crop land irrigated by rotating sprinkler systems would appear as circular shapes.

Size of objects in an image is a function of scale. It is important to assess the size of a target relative to other objects in a scene, as well as the absolute size, to aid in the interpretation of that target. A quick approximation of target size can direct interpretation to an appropriate result more quickly. For example, if an interpreter had to distinguish zones of land use, and had identified an area with a number of buildings in it, large buildings such as factories or warehouses would suggest commercial property, whereas small buildings would indicate residential use.

Pattern refers to the spatial arrangement of visibly discernible objects. Typically an orderly repetition of similar tones and textures will produce a distinctive and ultimately recognizable pattern. Orchards with evenly spaced trees, and urban streets with regularly spaced houses are good examples of pattern.



Texture refers to the arrangement and frequency of tonal variation in particular areas of an image. Rough textures would consist of a mottled tone where the grey levels change abruptly in a small area, whereas smooth textures would have very little tonal variation. Smooth textures are most often the result of uniform, even surfaces, such as fields, asphalt, or grasslands. A target with a rough surface and irregular structure, such as a forest canopy, results in a rough textured appearance. Texture is one of the most important elements for distinguishing features in radar imagery.

Shadow is also helpful in interpretation as it may provide an idea of the profile and relative height of a target or targets which may make identification easier. However, shadows can also reduce or eliminate interpretation in their area of influence, since targets within shadows are much less (or not at all) discernible from their surroundings. Shadow is also useful for enhancing or identifying topography and landforms, particularly in radar imagery.

Association takes into account the relationship between other recognizable objects or features in proximity to the target of interest. The identification of features that one would expect to associate with other features may provide information to facilitate identification. In the example given above, commercial properties may be associated with proximity to major transportation routes, whereas residential areas would be associated with schools, playgrounds, and sports fields. In our example, a lake is associated with boats, a marina, and adjacent recreational land.

3. a) What is GIS and Explain it's terminology.

Geographic Information System (GIS) is a computer-based tool that analyzes and displays data that is attached to a location on Earth. GIS uses database operations like statistical analysis and queries, along with maps, to provide visualization and geographic analysis.

GIS can be used to:

- Understand patterns, relationships, and geographic context
- Improve communication, efficiency, management, and decision-making
- Support decision making for planning and management of land use, natural resources, environment, transportation, and more

Some functions of GIS include: Data capture and management, Data analysis and modeling, Mapping and visualization, Sharing and collaboration, and Decision support and problem solving.

b) Write about key component's of GIS.

- ArcGIS: ArcGIS is a suite of GIS applications designed and licensed by Esri. ArcGIS for desktop includes the applications ArcMap, ArcCatalog, ArcScene, and ArcGlobe.
- ArcGIS Online: Esri's online GIS tool. Great for creating web-maps and sharing them with others. Has ready-made apps that you can use to feature your web-maps. Does not have the same capabilities of ArcMap or Pro, but seems to gain functionality all the time.
- ArcGIS Pro: A new addition to Esri's desktop GIS offerings. Pro is kind of a step between ArcMap and ArcGIS Online. Much of the functionality of ArcMap has been carried into ArcGIS Pro.
- ArcMap: The primary GIS application available in the ArcGIS software suite by Esri. ArcMap is the go to software for GIS professionals, though the line between ArcMap and ArcGIS Pro is getting fuzzier.
- Coordinate System: A reference framework consisting of a set of points, lines, and/or surfaces, and a set of rules, used to define the positions of points in space in either two or three dimensions. Cartesian coordinate

system and the geographic coordinate system used on the earth's surface are common examples of coordinate systems.[1]

- Datum: The reference specifications of a measurement system, usually a system of coordinate positions on a surface (a horizontal datum) or heights above or below a surface (a vertical datum).[1]
- DEM: Digital Elevation Model. The representation of continuous elevation values over a topographic surface by a regular array of z-values, referenced to a common datum. DEMs are typical used to represent terrain relief.[1]
- Esri: Esri is the industry leader in GIS. Esri standa for Environmental Systems Research Institute, but most just refer to it as "Esri." Esri is headquartered in Redlands, CA.
- Geocode: Or Geocoding. A GIS operation for placing points on a map based on street addresses. You can also plot x,y (lat, long) data.
- Geodatabase: A database or file structure used primarily to store, query, and manipulate spatial data. Geodatabases store geometry, a spatial reference system, attributes, and behavioral use data.[1] Geodatabases have become the standard file storage format in ArcGIS. Allows you to store many different data in one packaged file, rather than many shapefiles & associated files in a simple folder. Certain operations seem to run more smoothly when your data is packaged in a geodatabase.
- Georeference: An operation in which an image (such as an aerial photo) is aligned to a known coordinate system so it can be viewed and analyzed with other spatial data.[1] Typically, georeferencing involves overlaying an image above a basemap and aligning known points on the image with the basemap (such as an easily identified street intersection).
- GIS: (Geographic Information System) An integrated collection of computer software and data used to view and manage information about geographic places, analyze spatial relationships, and model spatial processes.[1]
- GIS "Lite": A commonly used and broad term describing GIS tools that are less full-featured and have a lower barrier to entry. Typically, GIS Lite tools are web-based, and require little advanced training. Examples:

Google Earth, Google Maps, ArcGIS Online (although ArcOnline is becoming more fully featured), other online mapping tools.

- Layer: The visual representation of a geographic dataset in any digital map environment. Conceptually, a layer is a slice or stradum of the geographic reality in a particular area, and is more or less equivalent to a legend item on a paper map.[1] When you add data (such as a shapefile) to a GIS application it is represented as a layer on a map.

- Map Document: Or .mxd file. The filetype for saving your workspace in ArcMap. 'Projection: A method by which the curved surface of the earth is portrayed on a flat surface. Every map projection distorts distance, area, shape, direction, or some combination thereof.[1]

- QGIS: A free and open-source (and fully featured) GIS platform. An alternative to ArcGIS. Also works on Macs.

- Raster Data: A spatial data model that defines space as an array of equally sized cells arranged in rows and columns.[1] Think of these cells as pixels.

- Shapefile: Or .shp. This is the most common filetype for geographic or spatial data, and is the most frequently used filetype in ArcGIS. Shapefiles come to you as points (placemarks, cities), lines (roads, rivers), or polygons (state boundaries, counties, zones). Free available shapefiles of all sorts of stuff are freely available on the web.

- Topology: The spatial relationships between connecting or adjacent features in a geographic data layer (for example, arcs, nodes, polygons, and points). Topological relationships are used for spatial modeling operations that do not require coordinate information.[1] Think of it as the relationships between things that are adjacent or connected to one another.

- Topography: The study and mapping of land surfaces, including relief (relative positions and elevations) and the position of natural and constructed features.[1] USGS Topo Maps are a prime example.

- Vector Data: A coordinate-based data model that represents geographic features as points, lines, and polygons.

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III B.Tech I Sem (R20) MID - 1 EXAMINATION

Subject:RS&GIS **Time : 10:00 am to 11:30 am** **Section : CIVIL**

MID -2 QUESTIONS WITH ANSWERS

1. Explain in detail about Map projections.

2. Explain the application of remote sensing in Land use Land cover mapping

3. Explain the role of Remote Sensing and GIS in urban applications in today's scenario.

1. Explain in detail about Map projections.

Maps are one of the oldest types of document and have been integral in the scientific expedition since ages. While the objective of map projections is basically deals with transforming the curved surface of the earth in to a flat surface, the greatest challenge one face is the shape of the earth itself. Since the earth is conceptually a spherical surface and while transforming into a flat surface reducing of scale becomes important so as to use it for reference. Thus distortion becomes the biggest hurdle. One of the simplest ways to map the earth surface without any kind of distortion is the globe. But it has its own disadvantages; it is expensive to make, difficult to practice (measure and draw on) and reproduce and difficult to carry. Another is that in globe only half of the globe is visible at one time. Thus all these drawbacks of globes can be solved out if a map is prepared on a flat surface. But constructing a map on a plane surface does require an important operation which requires mathematically converts features between a spherical or ellipsoidal surface to a projected flat surface.

Representing the curved earth on a flat paper or on a computer screen requires mapping of earth on the two dimensional (2D) mapping plane. Mapping on a 2D surface means transforming each and every point on the reference surface with geographic coordinates (ϕ, λ) into the set of projected coordinates (x, y) that can be represented on the position of the features on a flat surface. It is a systematic transformation of the latitudes and longitudes of a particular location on surface of the sphere into location on a flat surface. While projecting map on a flat surface distortion of the earth surface to some limited extent is obvious and thus, depending upon the purpose of the map, projections are applied in order to maintain or preserve some particular properties.

Metric Properties of Map

The metric properties of maps that need to preserve are;

a. Area

b. Shape

c. Distance

d. Direction

e. Bearing and

f. Scale.

Every map projection maintains these properties while the purpose of the map generally determines which of the map projection is best suitable. Another consideration in the configuration of a map projection is its compatibility with data sets to be used on the map. Data sets are geographic information, collected depending on the chosen datum (Model) of the Earth.

Scale factor and transformation

Projections are constructed in two stages; first the reduction of the size of the earth in reference to a hypothetical globe that is scale, second transform each and every point of the globe into a flat surface (x, y), that is transformation of Geographic coordinates into projected coordinates.

The scale factor is the transformation of globe scale that is representative fraction (RF), also called the ***Principal scale*** into a scale of a flat surface where the principal scale divides the radius of the earth by the radius of the globe. The scale factor (SF) is the actual scale divided by the principal scale.

Relationship between Coordinates and map projection:

The coordinates are the latitude and longitudinal position of an earth's point that are usually represented as (x, y). X refers to longitudinal position while y refers to latitudinal position of a particular earth's point. A coordinate system is super imposed on the map surface to provide the referencing framework by which x, y positions are can compute and measured.

Types of Map projection:

Map projection can be divided in terms of 7.1 Developable surface that are

a. Cylindrical: the developable surface is a cylinder

b. Conical: the developable surface is a cone

c. Planar or Azimuthal: the developable surface is a flat.

2. Explain the application of remote sensing in Land use Land cover mapping

There is ample collection of data produced from remote sensing and vary from the very highspatial resolution images (such as CartoSat, IKONOS and Quickbird), to regional datasets produced at regular intervals (e.g., LISS III, TM/ETM, SPOT), to lower spatial resolution (>250 m) images now produced daily across the entire Earth (e.g., MODIS). The temporal dynamics of the synoptic view of the earth's surface by satellite assisted data capture has given us an important tool to study the variations in land use and land cover over a period of time. The changes in the land use and land cover manifested as a function of the changes either natural or manmade, have a bearing on the reflectance patterns of incidence radiation due to the changes in the vegetative cover, soil moisture or the various modifications of the earth's surface (Navalgund, 2001). Since the changes in land use and land cover are more or less unidirectional, without much oscillation, it is safe to extrapolate the changes in spatial extents and also calculate the rate of changes. A very important tool in this regard is the Geographical Information System (GIS). The Geographic Information System is a powerful tool in which spatial information can be stored, organized, and retrieved in a user friendly environment. The Conjunction of satellite remote sensing data and ancillary data in a GIS environment combined with the Global positioning system (GPS) data is a potential tool to environment management. Land use and land cover change modelling First and foremost in land use and land cover change modelling is the generation of scenarios. This is because the relationship of the people with the land has the same origin as their evolution – the ability to modify their surroundings to suit themselves. Land use change is a locally pervasive and globally significant ecological trend. On a global scale, nearly 1.2 million km2 of forest have been converted to other uses during the last three centuries while cropland has increased by 12 million km2 during the same period. Currently, humans have transformed significant portions of the earth's land surface: 10–15% is dominated by agriculture or urban industrial areas and 6–8% is pasture. These changes in land use have important implications for future changes in the earth's climate and, in turn, greater implications for subsequent land use and land cover change. The surface heat and moisture budgets depend very much on land use and land cover which, in turn, affect atmospheric instability. Simulations of the plausible human influenced landscape changes following different scenarios may reveal strategic policies that should be modified to improve the environment. For a particular region, current trends coupled with historical land use patterns are used to model future land use. Numerous models have been used to build scenarios of the future: narrative method models and hybrid methods using both qualitative and quantitative methods (Jones 2005). Agrawal et al. (2002) have provided an exhaustive study on the various available land use and land cover change models. Most land use/change models incorporate three critical dimensions. Time and space are the first two dimensions and provide a common setting in which all bio-physical and human processes operate. The third dimension is the human process or the human decision-making dimension. The three dimensions of land use change models (space, time and human decision-making) and the two distinct attributes for each dimension (scale and complexity) are the foundations of the land use change models. Applications and Challenges of LULC modeling Applications • Provides support to understand the cause-effect relationships of land use dynamics • Helps in sustainable land use planning and optimizing policy making decisions • Valuable for unravelling the multifaceted suite of biophysical and socio-economic forces that impact the rate and spatial pattern of land use change • For estimating the possible impacts of changes in land use Challenges • Primary challenge is the availability of spatially and temporally varied consistent data which are representative of driving forces. • Linking remotely sensed outputs with social science analyses. Basic Requirements for LULC modeling • Scenarios generation • Historical and current land-cover maps • Socio economic, biophysical and environmental data • Identification of the driving forces

3.Explain the role of Remote Sensing and GIS in urban applications in today's scenario.

1. Land Use Classification

Accurate land-use classification is paramount for coherent urban planning. Remote sensing helps us delineate various land-use categories such as residential, commercial, industrial, and agricultural zones.

Through spectral imaging and utilizing various band combinations, **different land use types** can be identified and mapped with precision. Moreover, the temporal dimension of remote sensing allows us to track changes and anticipate future urban trajectories, enabling a data-driven approach towards sustainable land use and urban governance.

2. Environmental Monitoring

Embracing remote sensing for environmental monitoring has empowered urban planners to observe and analyse diverse environmental variables including air quality, water bodies' status, and vegetation cover.

The technology not only discerns the current environmental conditions but also helps in identifying trends, predicting future scenarios, and formulating strategies for sustainable development. For instance, monitoring air pollution through remote sensing is pivotal for shaping policies and actions for improved urban air quality.

3. Urban Expansion Analysis

The accelerated pace of urbanization demands meticulous analysis and strategic planning. Remote sensing allows us to precisely analyze urban expansion by monitoring changes in land use over time. This involves observing and interpreting patterns related to urban sprawl, densification, and land consumption.

By employing remote sensing, we navigate through past urban developments, scrutinize present conditions, and predict future expansions. This enlightens planners and policy-makers, ensuring informed and adaptive strategies for managing and mitigating the impacts of urban growth.

4. Traffic Management

A flourishing city invariably grapples with the complexity of managing vehicular traffic efficiently. Remote sensing unveils a revolutionary approach in understanding, analyzing, and managing urban traffic. Through satellite imagery and aerial photographs, we delineate **traffic patterns**, identify congestion zones, and scrutinize daily vehicular movement.

This data becomes instrumental in devising traffic management strategies, optimizing road networks, and improving transportation infrastructure, ensuring the smooth flow of traffic and enhanced urban mobility.

5. Disaster Management

With cities often nestled in disaster-prone areas, efficient disaster management becomes a cornerstone for urban planning. Remote sensing provides us with a multifaceted tool that not only aids in identifying and monitoring disaster-prone areas but also plays a pivotal role during and post-disaster scenarios.

UNIVERSAL COLLEGE OF ENGINEERING & TECHNOLOGY
IIIB.TechII Sem (R20) MID - 1 EXAMINATION

S ubject: GTE-II   Time : 02:50 pm to 04:20 pm   Date : 09.03.2023
Section : CIVIL

Answer the following questions   **Max. Marks : 30**

1. a) Enumerate the various methods of subsoil exploration. Describe the procedure to conduct the tandard Penetration Test and corrections to be applied

b) Explain pressure meter test.

2. Explain different types of shear failures of soil with neat sketch.

3. Describe the procedure to conduct the plate load test with a sketch and state its limitations.

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GUNTUR (Dist.)

MID -1 QUESTION PAPER WITH KEY

1. a) Enumerate the various methods of subsoil exploration. Describe the procedure to conduct the tandard Penetration Test and corrections to be applied

The process of soil exploration involves various methods and techniques, such as drilling boreholes, taking soil samples, and performing in-situ tests. These methods help in determining the soil's physical and engineering properties, such as bearing capacity, compressibility, and permeability.

Objectives of Soil Exploration

Following are some of the objectives of soil exploration:-

- Identification of the type of soil deposits.
- Determination of the depth and thickness of distinct soil strata and their extent in the horizontal direction.
- The location of groundwater as well as variations in groundwater level.
- Collecting soil and rock samples from the various strata.
- Determination of engineering parameters of soil and rock strata that affect structural performance.
- Performing field tests that are used to determine in-situ properties of the soil.
- To learn about the order in which soil and rock strata appear.
- To choose an appropriate type of foundation.
- To calculate the most likely and largest differential settlements.
- To determine the soil's bearing capacity.
- To forecast lateral earth pressures acting on retaining walls and abutments.
- To choose appropriate soil improvement practices.
- To select appropriate construction equipment.
- To predict the problems that can occur in the foundation of the structure and find its remedy.

Soil Samples in Soil Exploration

The quality of soil samples has a considerable impact on the results of laboratory tests. Two basic types of soil samples can be collected from trial pits or boreholes:-

Disturbed Samples

A disturbed sample is one in which the soil structure has been severely or entirely disrupted, and the moisture content may differ from the in-situ value. The in-situ particle size distribution of soil is preserved. These samples are necessary for identification and classification tests.

Undisturbed Samples

An undisturbed sample is one that keeps the true in-situ structure and moisture content of the soil as closely as possible. Undisturbed soil samples are required for the permeability, consolidation and shear strength tests.

Methods of Soil Exploration

Different methods or types of soil exploration are as follows:-

Direct Methods of Soil Exploration

The direct method of soil exploration includes:-

Test or Trial Pits

The test or trial pits are simple or open devices used for the purpose of soil exploration. Trial pits are typically used for shallow depth investigations. Any type of soil can be tested using this method of soil exploration. Test or trial pits are holes drilled to assist the geotechnical engineer in assessing the suitability of the ground for the foundation of the proposed construction.

Before beginning any work, geotechnical engineers can study the soil composition using test pits with approximate depths ranging from 3 to 15 feet deep, depending on soil stability. It is the most cost-effective approach to site exploration and requires no specialist equipment. It is simple to collect subsurface soil samples, which can then be used for suitable laboratory testing to determine the strength and other engineering parameters.

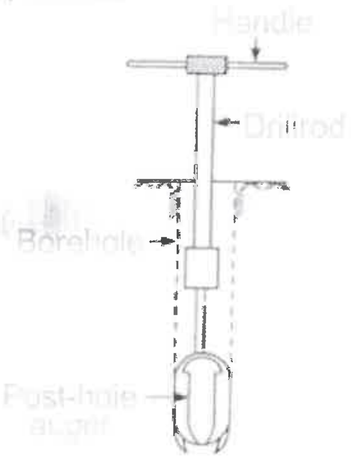
Semi Direct Methods of Soil Exploration

Semi Direct Methods of soil exploration basically involve the process of boring to examine the characteristics of the soil sample. Boring is the process of making or drilling holes in the earth in order to gather soil or rock samples at various depths. The various types of borings are as follows:-

Auger Boring

A soil auger is a device that aids in the advancement of a borehole into the ground. They are utilised above the water table in cohesive and other soft soils. There are two kinds of soil augers for the purpose of an auger boring method of soil exploration: hand-operated soil auger and power-driven soil augers.

Hand-operated augers are only used at shallow depths of 3 to 5 metres, but power-driven augers are more commonly used at deeper levels. The soil auger is driven downward by rotating it and pressing it into the soil at the same time. When the auger is fully loaded with soil, it is removed, and a soil sample is taken out for various tests.



Auger Boring

Fig.1: Auger Boring

Auger and Shell Boring

A pipe referred to as a "Shell" or "Casing" is used to prevent the soil from sliding because the hole's sidewalls cannot be left unsupported. Casings are suited for both sand and heavy clays. Firstly, the casing must be driven, and then the auger boring must be done by soil augers. Every time the casing needs to be extended, the auger must be removed, which slows down the job. Power-driven augers are used as part of a 'Boring Rig', which can reach as deep as 50 metres, whereas the manual rig can only go as deep as 25 metres.

Wash Boring

Wash Boring method of soil exploration is a quick and easy way to drill holes in the earth. The hole is bored to a shallow depth before the casing pipe is driven down into the soil to prevent the bore hole's walls from collapsing. To continue the boring operation, a chopping bit attached to the base of a hollow drill rod is employed. The drill rod, which is simultaneously elevated, dropped, and twisted, pushes water with pressure. The soil gets loosened due to the jetting and cutting movement. Soil is loosened as a result of its jetting and cutting action. The loosened soil is driven up to the ground surface in the form of soil water slurry through the annular space between the drill rod and the casing. The suspended soil settles in the tub, and the water goes into the sump, where it is utilised for circulation. The change of soil stratification can be predicted from the rate of progress and colour of wash water. The soil sample obtained can be used for various tests for soil exploration.

Percussion Boring

In percussion boring, the soil is reduced by repeatedly striking it with a hefty drilling bit. The bit is known as the churn bit. The bit is attached to the end of a drilling rod and is raised and dropped in the borehole alternately. Water is introduced to aid in the breaking down of the soil. Bailers or sand pumps are used to remove the slurry that forms at the bottom of the hole. Percussion Boring is appropriate for boring in rocks and hard soils.

Rotary Boring

Rotary boring is only utilised for soil investigation when deep boreholes are needed in challenging formations containing boulders, fractured rock, or waterlogged sand. In the rotary boring method, a power rig rotates a cutter bit or a core barrel with a coring bit attached to the lower end of drill rods. The material is sliced, chipped, and grounded into little pieces by the bit. Pumping water or drilling mud through the hollow drilling rod extracts the material. No casing is required for the hole if drilling mud is employed in the rotary boring method of soil exploration.

1b) Explain pressure meter test

Parts of Pressuremeter

Pressuremeter contains three parts namely:

- Probe
- Tubing
- Control unit

Probe consists of three cells which one above the other as shown in figure. All the three cells are inflatable. The middle cell is the measuring cell or main cell which is filled with water during test. The other two cells which are at the top and bottom of measuring cell are known as guard cells which protects the main cell from the end effects caused by finite length of cable.

The whole arrangement of probe is generally protected by the metal shield as shown in picture. To pump the water and gas into measuring cell and guard cells a rigid hollow tube is arranged through the three cells. Control unit is set up near the borehole and is connected to tubing by hollow cables to control the pressure in the cells by pumping water

Procedure of Pressuremeter Test on Soil

The test procedure consists of three steps as follows:

- Drilling borehole
- Positioning of probe in the bore bole
- Conducting test

Drilling Borehole

The Menard's pressuremeter is not used to drill the borehole. To drill a borehole separate drilling equipment is used and preferably which causes least disturbance to the soil while drilling. The diameter of the borehole should be in between 1.03 times to 1.20 times the diameter of the probe.

$1.03D_p < D_h < 1.20D_p$

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Different designations are there for the diameter of borehole with respect to diameter of probe and length of measuring cell (l_0) and probe (L) which are tabulated below.

Designation of borehole diameter	Diameter of probe (mm)	Length of measuring cell (l_0) (mm)	Length of probe (l) (mm)	Nominal diameter of borehole (mm)	Maximum diameter of borehole (mm)
AX	44	360	660	46	52
BX	58	210	420	60	66
CX	70	250	500	72	84

Positioning of Probe in Borehole
After drilling the hole, the probe is lowered down to the required elevation using cables. The probe should be lowered slowly without disturbing the surrounding soil and the apparatus itself. After reached desired elevation, the probe is fixed using clamping device.
Conducting Pressuremeter Test on Soil
After the positioning of probe, now it's time to fill the cells of probe with water and gas. This action is done by using control unit of the pressuremeter. The valves of the control unit are opened which admits water into the measuring cell and gas into the guard cells respectively. Equal pressure is maintained in both the measuring and guard cells. Now, using measuring cell pressure is applied on the soil wall of borehole. The application of pressure can be done by any of the two methods as follows:

- Equivalent pressure increment method
- Equivalent volume increment method

Equivalent pressure increment method, in which certain amount of time (generally one minute) and pressure increment value is fixed for that time. After the completion of time, the volume change is noted. Similarly, same pressure increments for the next one minute of time is applied and volume change is noted. This process is repeated until limited pressure is reached. In general, ten equal pressure increments for 10 minutes of time are enough to reach the pressure limit. Equivalent volume increment method, in this method the probe volume is increased by 5% for each increment. After each increment the probe is held constant for 30 seconds. After every 30 seconds the pressure readings are noted. Finally The reading will helps to obtain the stress strain curve of soil.
Results of Pressuremeter Test
The volume of water used for each increment of the probe volume is taken on x- axis and the pressure value obtained for each increment is taken on y-axis. The curve obtained may contain some errors. To overcome this, the pressuremeter should be calibrated for pressure loss, volume loss and hydrostatic pressure head before it is used in the design.

2. a) Explain different types of shear failures of soil with neat sketch
Types of shear failure of foundation soils
Depending on the stiffness of foundation soil and depth of foundation, the following are the modes of shear failure experienced by the foundation soil.

1. General shear failure (Fig.1(a))
2. Local shear failure (Fig.1(b))
3. Punching shear failure (Fig.1(c))

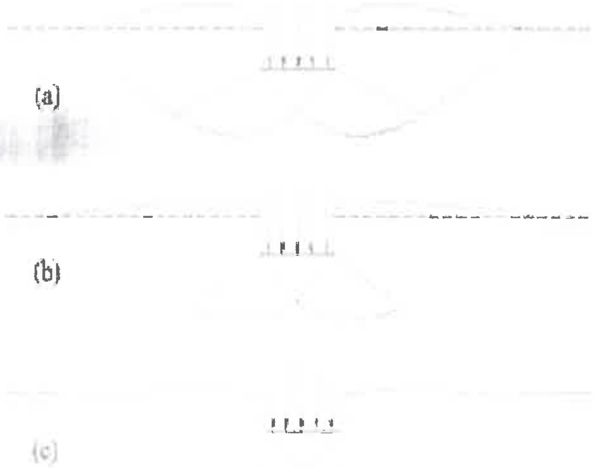


Fig.1: Shear failure in foundation soil

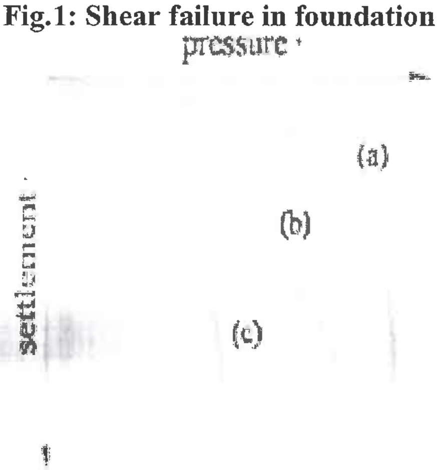


Fig: P – Δ Curve in different foundation soils

General Shear Failure

This type of failure is seen in dense and stiff soil. The following are some characteristics of general shear failure.

1. Continuous, well defined and distinct failure surface develops between the edge of footing and ground surface.
2. Dense or stiff soil that undergoes low compressibility experiences this failure.
3. Continuous bulging of shear mass adjacent to footing is visible.
4. Failure is accompanied by tilting of footing.
5. Failure is sudden and catastrophic with pronounced peak in $p-\Delta$ curve.
6. The length of disturbance beyond the edge of footing is large.
7. State of plastic equilibrium is reached initially at the footing edge and spreads gradually downwards and outwards.
8. General shear failure is accompanied by low strain (<5%) in a soil with considerable ϕ (ϕ>36°) and large N (N > 30) having high relative density (I_D> 70%).

Local Shear Failure

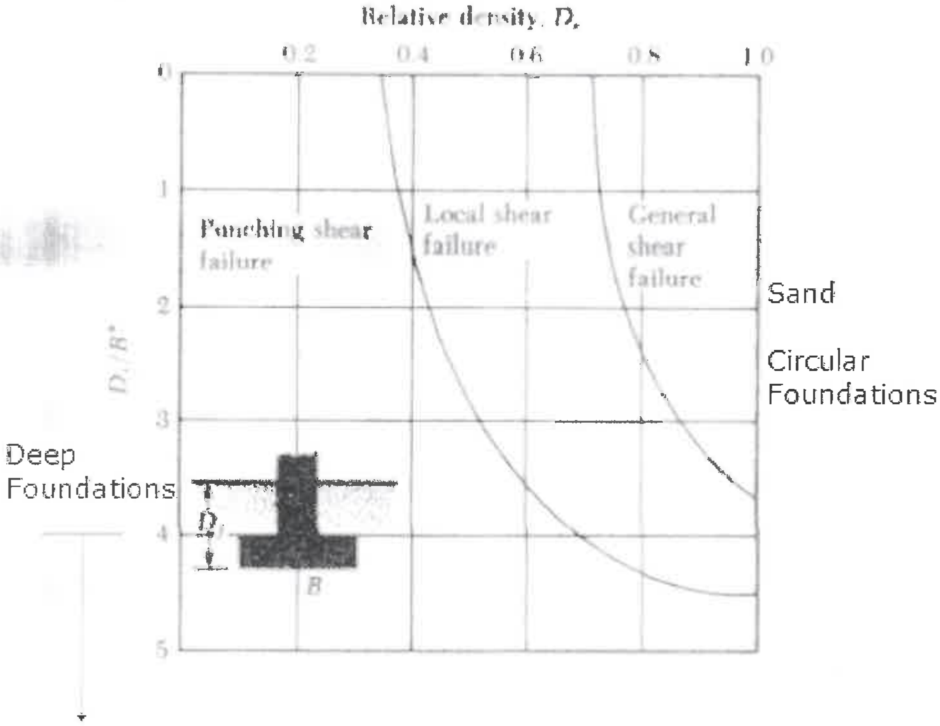
This type of failure is seen in relatively loose and soft soil. The following are some characteristics of general shear failure.

1. A significant compression of soil below the footing and partial development of plastic equilibrium is observed.
2. Failure is not sudden and there is no tilting of footing.
3. Failure surface does not reach the ground surface and slight bulging of soil around the footing is observed.
4. Failure surface is not well defined.
5. Failure is characterized by considerable settlement.\
6. Well defined peak is absent in $p-\Delta$ curve.
7. Local shear failure is accompanied by large strain (> 10 to 20%) in a soil with considerably low ϕ (ϕ<28o) and low N (N < 5) having low relative density (I_D> 20%).

Punching Shear Failure of foundation soils

This type of failure is seen in loose and soft soil and at deeper elevations. The following are some characteristics of general shear failure.

1. This type of failure occurs in a soil of very high compressibility.
2. Failure pattern is not observed.
3. Bulging of soil around the footing is absent.
4. Failure is characterized by very large settlement.
5. Continuous settlement with no increase in P is observed in $p-\Delta$ curve.



3. Describe the procedure to conduct the plate load test with a sketch and state its limitations.

- In the gravity loading method of the plate load test, a platform is built over the column, and sandbags are placed for the application of the load.
- The hydraulic jack is placed between the column and the loading platform so that the load can be applied gradually. Such loading is termed reaction loading.
- Three dial gauges are set up on the platform at the diagonal corners of the plate to measure the plate settlement.
- A seating load of **0.7** (Tone/m2)(Tone/m2) is applied initially in order to compact the load.
- Soon after, loading is applied at the rate of **0.25 mm/hour.**
- The load is applied using the hydraulic jack, and the force is slowly increased. The increment is usually one-fifth of the expected safe bearing capacity, one-tenth of the ultimate bearing capacity, or any smaller value.
- The load is measured by the pressure gauge.
- Upon application of each load increment, settlement is measured on the dial gauge. The settlement should be checked after 1, 4, 10, 20, 40, and 60 minutes, and then every hour until the rate of settlement is less than 0.02 mm per hour.
- After all the data for a certain load have been collected, the next load increment is added, and readings are taken under the new load.
- This process of increasing the load and collecting the data is repeated until the maximum load is applied. The maximum load is 1.5 times the expected ultimate load or 3 times the expected maximum pressure.

Method of Plate Load Test

- Reaction truss method
- Gravity loading platform method

Reaction Truss Method

- In this method, the movement of the hydraulic jack is affected by the reaction truss.
- Soil anchors keep the truss in place on the ground.
- With the help of hammers, the anchors are driven deep into the ground.
- Mostly Mild steel sections are used to construct the reaction truss. For the truss to be stable on the sides, ropes are used.
- The reaction truss is extensively used in the plate load test since it is easy, quick, and less tedious.

Gravity Loading Platform Method

- In this form of plate load case, a platform is built on top of a vertical column that rests on the test plate. Sandbags, stones, or concrete blocks are used to load the platform.
- The test plate settles upon the application of this load. With the help of dial gauges, the settlement is ascertained.
- Two dial gauges attached to a datum bar are used for the square plate.
- As the plate settles, the ram of the dial gauges moves down.
- Load is measured from the load gauges on the hydraulic jack.

Calculation of Bearing Capacity from Plate Load Test

- At a certain depth, a **30cm x 30cm** square plate or a 30cm diameter circular plate is placed in the foundation.
- Then, a gradual load is applied to the plate.
- Each time the load increases, the foundation settles down due to pressure.
- The bearing capacity of the soil is ascertained from the settlement.

The equation relating the bearing capacities and the settlement is:
(SpBp=SfBf)(SpBp=SfBf)

- From the results of the plate load test, a logarithmic graph is plotted to represent the relationship between the load and the settlement.

- The x-axis represents the load, and the y-axis shows the settlement due to the load.
- From this load-settlement curve, the ultimate bearing capacity of the soil can be determined along with the settlements corresponding to different loads.

UNIVERSAL COLLEGE OF ENGINEERING & TECHNOLOGY

IIIB.TechII Sem (R20) MID - 1 EXAMINATION

Subject: GTE-II Time : 02:50 pm to 04:20 pm Section : CIVIL

Answer the following questions

Max. Marks : 30

1. Explain Skempton's bearing capacity theory?

2. a) Explain any one formula to determine the safe bearing pressure based on N- value?
   b) Summarise the harmful effects of differential settlement on structures? What are the possible remedial measures?

3. Summarise tilts and shifts of wells?

MID -2 QUESTION PAPER WITH KEY

1. Explain Skempton's bearing capacity theory?

Skempton 1951 suggested a bearing capacity theory for saturated clay for which É¸ = 0. Skempton gives N_c, the bearing capacity factor on the basis of theory, laboratory tests and field observations. It was found that the value of N_c increased with the increase in D_f/B ratio. The expression for N_c proposed by Skempton is given below.

For Strip footings,

$N_c = 5(1+0.2D_f/B)$, with a maximum limiting value of 7.5 ——— (1)

For square and circular footings,

$N_c = 6(1+0.2D_f/B)$, with a maximum limiting value of 9.0 ——— (2)

For rectangular footings,

$N_c = 5(1+0.2D_f/B)(1+0.2B/L)$ for D_f/B â‰¤ 2.5 ——— (3)

$7.5(1+0.2D_f/B)(1+0.2B/L)$ for $D_f/B > 2.5$ ——— (4)

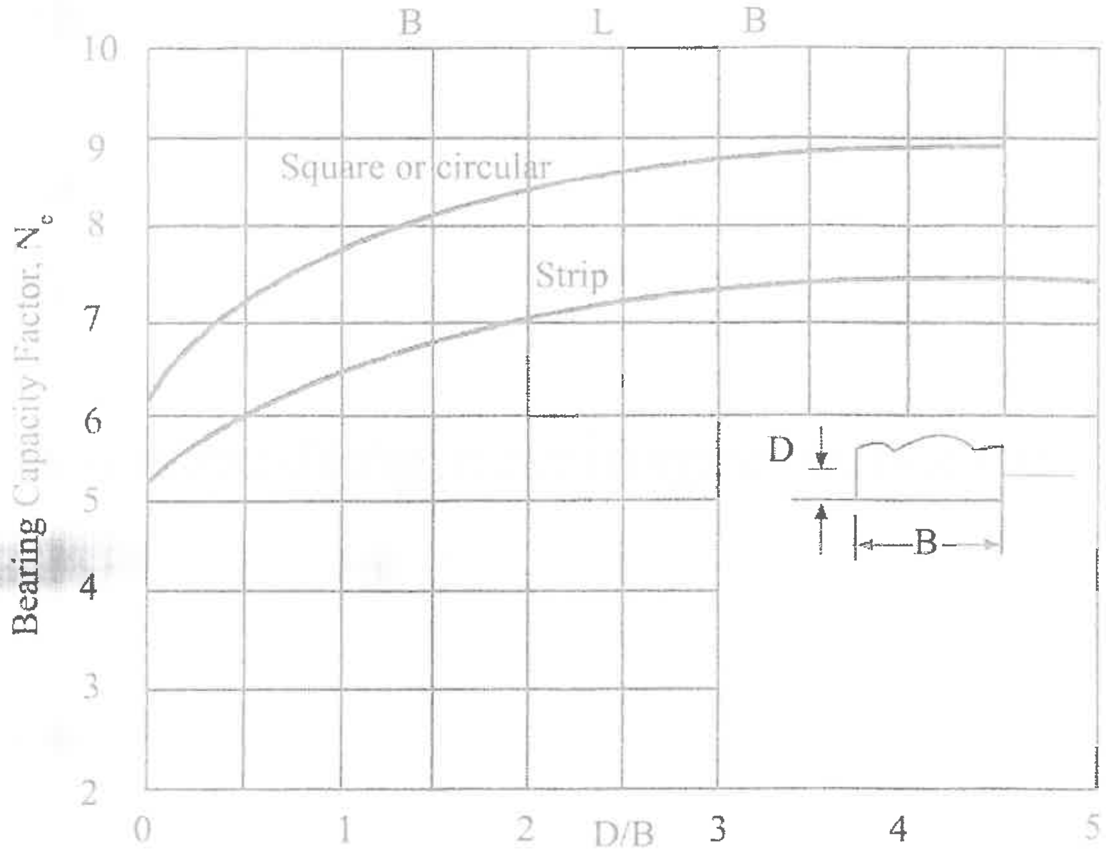


Fig 1 Skempton's Bearing Capacity Factor N_c

For É¸ = 0 condition, the net ultimate bearing capacity is given by:

$Q_{net} = c_u$NÃ§ ——— (5)

Alternatively, the graph given in Fig.1 above can be used to find the bearing capacity factor N_c. Where, N_c (rect) = N_c(sq)[0.84 + 0.16B/L] . As per Skemption, if the shear strength of the soil does not vary more than ± 50 % of the average value for a depth 2/3B below the footing, the average value of c_u can be used in the above equation.

2A) Explain any one formula to determine the safe bearing pressure based on N- value?

The formula for the ultimate bearing capacity of a circular footing is:
Terzaghi [3] introduced the concept of ultimate bearing capacity (q_u) and presented a comprehensive theory for the evaluation of such capacity under shallow foundations. For circular footings:
$qu=1.3cNc+\gamma 1DNq+0.3\gamma 2BN\gamma$[1.3]where; N_c, N_q, N_γ, are functions of internal friction angle, ϕ.
D and B are foundation depth and footing diameter respectively.
γ_1 and γ_2 are soil unit weight of fill and foundation soil respectively.
c is soil cohesion.
For surface foundation on undrained saturated clay, $N_c = 5.7$, $N_q = 1$ and $N_\gamma = 0$ and $q_u = 1.3cN_c$.
The general bearing capacity theories proposed by Meyerhof [4], Hansen [5], Vesic [6] and others are used in foundation design checking on critical bearing capacity in the presence of loose and soft layers. The effect of ground water table is considered by calculating the soil effective stresses within the soil surface and deeper layers that extend to a depth equals the footing width below the foundation level.

2. Summarise the harmful effects of differential settlement on structures?What are the possible remedial measures?

"Differential settlement" refers to a process of uneven structure settlement. The reasons can vary, but the most common is the unequal weight distribution of a building. This poor distribution will disrupt the foundation from bearing the load of the structure and allow it to sink into the ground, leading to severe structural damage.
On the other hand, settlement can come from the soil too. If the soil begins to expand, contract, and eventually shift, it will cause the building to settle unevenly. Such behavior comes from a range of factors that include drought, floods, massive tree roots, run-down water lines, and even poor drainage. Still, it's possible to see the warning signs before it's too late.
In case you find cracks in the concrete and the brick veneer, or your doors and windows aren't working properly, you should suspect that you're dealing with differential settlement. The cracks and fractures can allow moisture and pests to enter your lower-grade level. And on the other hand, your windows and doors that don't work will affect temperature levels. Unfortunately, these are just small-time symptoms, and the main issue is even worse.
Reasons Behind Differential Settlement
As we've said, differential settlement doesn't come out of the blue. Like other construction problems, it has its roots in the building process itself. And since the soil is a major factor, we're going to look at two of its common types in Michigan and how they can affect your foundation.
Expansive Clay
The first example is expansive clay. In case you do more research about it, you'll soon realize that it's not exactly your best friend when it comes to construction. Depending on the weather conditions in your area, clay will either expand or shrink. Its properties are pretty similar to that of a sponge.
When it comes in contact with water, clay will expand, and when there's a drought, it will reduce in size. Experts also call it highly expansive soil, and the name speaks for itself. These physical attributes of clay will affect a home without a proper foundation beneath it. Moreover, they will make it settle.
Bedrock/Load-Bearing Soil
Opposite to clay, bedrock, or load-bearing strata as some call it, is one of the strongest supports for a foundation. However, its strength and durability don't guarantee that you won't have problems with differential settlement. To put it in construction terms, bedrock will interfere with the footing trenches, causing the structure to sink unevenly.
Engineers have serious problems while constructing a building on rocky and hilly terrains. This is due to shallow and outcropping bedrock that will make one part of the home sit on soft and the other on

UNIVERSAL COLLEGE OF ENGINEERING & TECHNOLOGY

IVB.TechI Sem (R20) MID - 1 EXAMINATION

Subject:Urban Transportation &PlanningTime : 02:50 pm to 04:20 pm Date : 20.09.2023

Section : CIVIL

Answer the following questions

Max. Marks :15

1. a) Describe various urban transportation problems and issues.

   b) Distinguish between cordon lines and screen lines.

2. Write a note on the following: (a) BRTS, (b) Metro trains.

3. What is zoning? Discuss the points to be kept in the mind while doing zoning

MID EXAMINATION -1 QUESTIONS WITH ANSWERS

1.a) Describe various urban transportation problems and issues.

Urban transportation problems include:

- **Congestion**: Congested roads, low lane capacity, and traffic accidents
- **Poor quality roads**: Bad roads can hinder the movement of goods and services
- **Lack of parking**: Insufficient parking spaces
- **Air pollution**: Traffic pollution can contribute to climate change
- **Inadequate public transit**: Insufficient buses or trains, or trains that are not functional
- **High commuting distances**: Automobile-dependent cities can have longer commuting distances
- **High congestion costs**: Cities can face higher costs due to congestion
- **Lack of coordination**: A lack of coordination between land use and transportation planning agencies
- **Restrictive funding**: Overly restrictive funding programs can be a problem
- **Overlapping jurisdictions**: Overlapping jurisdictions can cause issues

2.Write a note on the following: (a) BRTS, (b) Metro trains.

(a) BRTS

Concept

- BRTS (Bus Rapid Transit System) is a term applied to a public transport systems using buses to provide faster, more efficient service than an ordinary bus line.
- It ensures fast, reliable, secure and high capacity service.

Aim

- To approach the service quality of rail transit while still enjoying the cost savings and flexibility of bus transit.

Objectives

- Considering factors are travel demand, ease of implementation and potential of the route as an independent route.

Advantages of BRTS

- Greater flexibility in route options
- Faster development
- Feasibility of incremental capital investments

Disadvantages of BRTS

- Lack of availability of dedicated lane capacity in urban areas.
- Allocation of existing lanes to BRTS may worsen traffic congestion in a corridor.

Types of BRTS

- Kerb Guilded Bus Way (KGB)
- Dedicated Lane with Open System
- Dedicated Lane with Closed System

BRTS in India

- Rajkot BRTS
- Ahmedabad BRTS
- Surat BRTS
- Jaipur BRTS
- Indore BRTS
- Bhopal BRTS

b) Metro trains.

Metro trains are one of the modern public transportation facilities. Most people travel by metro train to reach their destination faster. Since it is the cheapest and most convenient mode of transport, people rely on it. In this essay on metro train, we will see the experience of travelling in a metro train and understand its importance.

In this part of the essay on metro train, we will see its unique features and benefits. A metro train runs within a city, and it is established with the aim of covering large distances in a short time. We know how tedious it could be to travel by road from one place to another in a big city like Bangalore, Delhi or **Mumbai**. With the never-ending traffic, we will lose our energy and time by driving or taking other means of public transport. Metro trains provide a huge relief to this situation as we can reach our desired place without wasting much time.

Besides, we need to spend only half the price taken by a taxi while travelling in a metro train. Metro trains have been introduced for our benefit and convenience, and this essay

.

3. What is zoning? Discuss the points to be kept in the mind while doing zoning

Zoning refers to municipal or local laws and regulations that govern how real property can and cannot be used in certain geographic areas. For example, zoning laws can limit commercial or industrial use of land to prevent oil, manufacturing, or other types of businesses from building in residential neighborhoods.

These laws can be modified or suspended if the construction of a property will serve to help the community advance economically.

Key Takeaways

- Zoning allows local governments to regulate which areas under their jurisdiction may have real estate or land used for particular purposes.
- Examples of zoning classifications include residential, commercial, agricultural, industrial, or hotel/hospitality, among other more specific designations.
- Zoning laws can be changed by a local government as long as they fall within the state and federal statutes, and a particular plot of land may be rezoned based on consideration.

How Zoning Works

Zoning outlines what types of developmental and operational use of land is allowed on a given tract. Municipalities tend to partition districts and neighborhoods according to a master plan. This may be done to promote economic development, control traffic flow, manage noise levels, reserve living space for residents, and protect certain resources.

Examples of zoning classifications include industrial, light industrial, commercial, light commercial, agricultural, single-family residential, multiunit residential, and schools.

Local governments might ban the use of residential property for business purposes to keep commercial activity confined to specific parts of town. Such zoning can lead to conflicts if residents dispute the designated usage.

Zoning laws can also regulate the details of construction in specific neighborhoods. For example, zoning can limit the maximum height of buildings in a given area regardless of the type of construction allowed. High-rise residences or offices could be banned on particular parcels through zoning, regardless of whether the buildings otherwise comply with the laws.

The presence of zoning restrictions can influence prices when purchasing a piece of property. Real estate might sell at a premium based on how many limits were put in place by the municipality.

In 1926, the U.S. Supreme Court ruled that properly drawn zoning ordinances were a valid exercise of states' governing power. Zoning became constitutional by the court as a result of the case of Village of Euclid v. Ambler Realty.1

Economic Theory of Zoning

According to Nobel Prize-winning economist Ronald Coase's Theorem, in the absence of transaction costs, questions and disputes over land use and development could be solved optimally without government regulation. Under the assumptions of Coase's Theorem, the usage of a given piece of land and the type of activities that should be permitted could simply be negotiated among the parties involved to achieve an economically efficient outcome.23

Coase's Theorem illustrates why, in the real world—where transaction costs do occur and frictionless bargaining among stakeholders is unlikely—land use regulations such as zoning and other government-imposed solutions are the norm.

Critiques of Zoning Law

There are varied critiques of traditional zoning implementation.

Some critics claim that zoning creates and widens the disparity of quality of life among socioeconomic groups.4 For example, a township might maintain zoning laws that restrict heavy industrial and commercial development to tracts of land adjacent to lower-income neighborhoods. The effects of such policies would let more affluent parts of town avoid the associated noise and pollution.

Areas that continue to be zoned for low-density residential neighborhoods with a housing shortage are contributing to homelessness in their area by refusing to allow more residential housing units to be built.

A more modern critique of zoning that segregates commercial and residential areas is that it makes residents dependent on cars. A more integrated, walkable neighborhood where people could get groceries, work, and enjoy entertainment close to their homes would allow them to forgo the environmental and financial costs of car ownership. If zoning allowed for walkable neighborhoods, less space would have to be devoted to roads and more space could be reserved for housing and green space.

Mixed-Use Zoning

Mixed-use zoning is a structure that allows for a combination of residential, commercial, and sometimes industrial uses within a single area or building. One of the primary advantages is the creation of vibrant, walkable neighborhoods where people can live, work, and shop in close proximity. For example, the mixed-use development of Times Square in New York City combines entertainment, retail, office space, and residential units, turning the area into a bustling economic hub.

Despite those benefits, mixed-use zoning also presents several challenges. One of the primary issues is the potential for conflicts between different land uses. For instance, noise and activity from commercial establishments can disrupt residential areas, leading to complaints and tension among residents and business owners.

Another challenge is the complexity and cost of developing mixed-use projects. These developments often require more intricate planning, design, and construction processes compared to single-use projects. In San Francisco, the high costs associated with mixed-use developments, such as in the Mission Bay neighborhood, can be a barrier for developers.5 Financing mixed-use projects can also be more complicated as they may have more risk while also having unclear revenue streams and logistical challenges.

Conditional Use Permits and Zoning

Conditional use permits (CUPs) are tools in zoning that allow property owners to use their land in ways that are not typically permitted under the current zoning regulations. The catch is that certain conditions must be met.

These permits are useful for activities that could potentially have significant impacts on the surrounding community but are beneficial and necessary. For example, schools, hospitals, and religious institutions often require CUPs to operate in residential zones. These uses are generally supported because they serve as a public good, but they require careful regulation to ensure they do not negatively impact the neighborhood's character or infrastructure.

The process of obtaining a CUP involves a thorough review by local planning authorities to assess the potential effects of the proposed use. Since the proposal deviates from local regulation, it is often closely reviewed. This includes evaluating factors such as traffic generation, noise, and compatibility with surrounding land uses. Public hearings are typically part of the process, allowing community members to express their support or concerns.

Special Considerations

Alterations to zoning laws are possible even without full repeals of the current legislation. A developer or property owner can apply for variances that would allow certain exceptions to zoning regulations. This would let property be used in ways generally not permitted. For example, the owner of a home-based business might request a variance to allow the operations to continue.

Applicants for variances might be required to explain why the variance is needed and how the change will not cause significant disruption or detriment to the surrounding community.

General Examples of Zoning

One real-world example of zoning's impact on property values is the implementation of mixed-use zoning in Portland, Oregon. By allowing residential, commercial, and recreational spaces to coexist, mixed-use zoning has led to the revitalization of neighborhoods, increased walkability, and enhanced community engagement. This type of zoning has significantly boosted property values as residents are willing to pay a premium for the convenience and vibrant atmosphere that mixed-use developments offer.67

Zoning can also protect and enhance property values by preserving community character and preventing incompatible land uses. In historic districts such as Savannah, Georgia, zoning laws ensure that new developments are keeping with the area's architectural heritage. These regulations help maintain the aesthetic appeal and cultural significance of the district, thereby sustaining higher property values while also preserving history.8

Who Controls Zoning?

There is no federal agency for zoning so who controls the zoning in your area depends almost entirely on where you live. It is controlled at the county level in some cases or at the city level in others. Sometimes zoning is decided by a zoning office, and sometimes it is controlled by a land use office.

How Can You Get the Zoning Changed on Something?

First, you'll have to figure out who controls the zoning in your area. Then they usually will have a process by which you can appeal the zoning on something, but the specific steps will vary depending on where you live. Getting advice from a local real estate lawyer is advisable.

Can Zoning Laws Stop Me From Building on My Property?

Yes. You may own the land on which you want to build but you still will have to abide by zoning laws that may say you can't build a building of a certain size, or for a certain purpose, or any number of other regulations.

Why Is Zoning Important?

Zoning is important because it helps manage urban growth and development, ensuring that land use is compatible and beneficial to the community. It prevents incompatible land uses from being adjacent to each other, such as industrial facilities next to residential areas.

How Do I Find My Property's Zoning Designation?

To find your property's zoning designation, you can visit your local zoning or planning department's website where zoning maps and information are typically available. Many municipalities also offer interactive online maps that allow you to search by address.

The Bottom Line

Zoning was originally created to design uniform neighborhoods, control traffic patterns, and—when done right—allow room for a city to grow. Zoning implementation has had several unintended consequences and unfortunately contributed to increased income inequality and racial wealth disparities. To keep with modern times, zoning practices will have to adapt to growing populations and their needs.

Article Sources

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IVB.TechI Sem CIVIL (R20) MID - 2 EXAMINATION

Subject:Urban Transportation & PlanningTime : 02:50 pm to 04:20 p Date : 16.12.2023

Answer the following questions **Max. Marks :15**

1. Explain briefly about: (a) Gravity models, (b) Opportunity models.
2. What are the basic elements of transport network?
3. Briefly explain about environmental and energy analysis?

MID EXAMINATION -II QUESTIONS WITH ANSWERS

1. Explain briefly about: (a) Gravity models, (b) Opportunity models.

The Gravity Model

The gravity model is the most common example of spatial interaction modeling. The gravity model uses two variables to predict or estimate the volume of spatial interaction between or among places, be they cities, counties, or regions. These are (1) population totals of the places and (2) the distance separating these places or the time or cost of overcoming distance. The expectation is that there will be a positive association between flow volume and population size; that is, when two places have large populations we expect the volume of migrants or commuters to be large, but when places are separated by a great distance we expect that the effect of distance, as mediated by distance, cost, or travel time, will reduce the level of interaction. Thus, whereas population size leads to a positive relationship, distance leads to an inverse correlation (the volume of spatial interaction decreases as distance separation increases). The gravity model is written as follows:

Iij=kPi·PjDijb

where I_{ij} is the estimate of the volume of spatial interaction between place of origin *i* and place of destination *j*, *k* is a constant, D_{ij} is the distance between *i* and *j*, *b* is the exponent of distance, and P_i and P_j represent the population sizes of the places of origin and destination. The values of *k* and *b* vary depending on the specific data set.

View chapterExplore book

Transportation Geography

G. Giuliano, in International Encyclopedia of the Social &Behavioral Sciences, 2001

2.1.1 Aggregate models

Various forms of spatial interaction models have been applied in aggregate analysis, most commonly the gravity model. The gravity model incorporates two basic factors that affect the level of flow between places: the population of each place (or some measure of potential for flow), and the distance between them:

The model in Eqn. 1 states that flow from origin *i* to destination *j* is a positive function of (a)

(1)Tij=OiAjdij−β∑κAkdij−β

the potential of the origin zone for generating trips and (b) the relative attractiveness of the destination zone, and is a negative function of the distance between them. Gravity models have been applied to many topics, from intercity transport to local shopping flows. They have been extended to account for alternative travel destinations (intervening opportunities) as in the example above, differences in nodal characteristics, and differences in travel costs across modes or links (Taaffe et al. 1996).

The widespread availability of geographic information systems (GIS) has made possible the use of gravity formulations to measure accessibility patterns of different modes or population segments and hence analyze such policy issues as the distribution consequences of urban transport investment. The gravity model plays an integral role in state-of-practice urban transportation planning models: trip distribution (the allocation of trips to specific zonal destinations) is accomplished using a model that accounts for the relative attractiveness of zones as destinations and expresses distance as a generalized cost.

Opportunity models.

Gravity model is by far the most commonly used aggregate trip distribution model. But the gravity model does not exhaust all the theoretical possibilities. Intervening opportunities model which although much less used; offer real alternatives to the gravity model. The basic idea behind the intervening-opportunities model is that trip making is not explicitly related to distance but to the relative accessibility of opportunities for satisfying the objective of the trip. The original proponent of this approach was Stouffer (1940), who also applied his ideas to migration and the location of services and residences. But it was Schneider (1959) who developed the theory in the way it is presented today. Consider first a zone of origin i and rank all possible destinations in order of increasing distance from i. Then look at one origin-destination pair (i, j), where j is the mth destination in order of distance from i. There are m-1 alternative destinations actually closer (more accessible) from i. A trip maker would certainly consider those destinations as possible locations to satisfy the need giving rise to the journey: those are the intervening opportunities influencing a destination choice. The basic hypothesis of this model given by Stouffer (1940) is that the number of trips from an origin zone to a destination zone is directly proportional to the number of opportunities at the destination zone and inversely proportional to the number of intervening opportunities. This hypothesis may be expressed as: $t_{ij} = (k.a_j/v_j)$ Where; a_j = the total number of destination opportunities in zone j v_j = the number of intervening destination opportunities between zones i and j k =a proportionality constant to ensure that all trips with origins at zone i are distributed to destination opportunities. 5

2. What are the basic elements of transport network?

The main structural components of transport networks are:

- **Node**. Any location that has access to a transportation network.
- **Link**. Physical transport infrastructures enabling two nodes to be connected.
- **Flow**. The amount of traffic that circulates on a link between two nodes and the amount of traffic going through a node. Flows can thus be modal, intermodal (between modes) and transmodal (between components of the same mode).
- **Gateway**. A node that is connecting two different systems of circulation that are usually separate networks (modes) and which acts as a compulsory passage for various flows. An intermodal function is performed so that passengers or freight are transferred from one network to the other.

- **Hub.** A node that is handling a substantial amount of traffic and connects elements of the same transport network, or different scales of the network (e.g. regional and international).
- **Feeder.** A node that is linked to a hub. It organizes the direction of flows along a corridor and can be considered as a consolidation and distribution point.
- **Corridor.** A sequence of nodes and links supporting modal flows of passengers or freight. They are generally concentrated along a communication axis, have a linear orientation and connected to a gateway.

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3.Briefly explain about environmental and energy analysis?

Energy and environmental analysis is the study of how energy use impacts the world, and how to develop policies and practices for a sustainable planet. It can include:

- Assessing energy production and consumption: Environmental analysis can help evaluate the effects of energy production and consumption, and promote the use of renewable energy sources.
- Improving energy efficiency: Environmental analysis can help improve energy efficiency.
- Analyzing energy markets, policy, and infrastructure: Energy analysis can focus on energy markets, policy, and infrastructure.
- Analyzing energy and environmental systems: Energy analysis can include analyzing energy and environmental systems.
- Analyzing appliance and equipment standards: Energy analysis can include analyzing appliance and equipment standards.