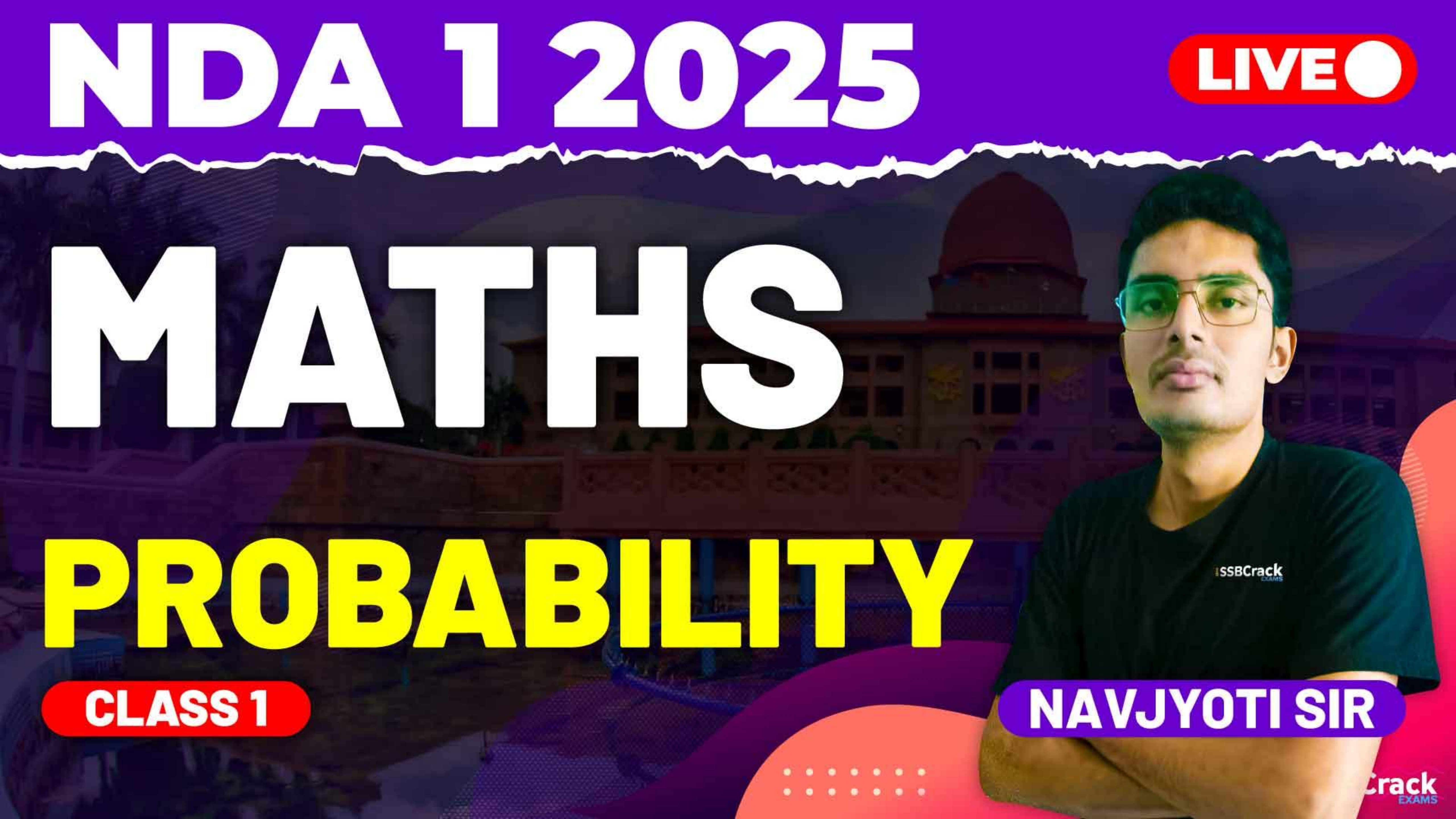
NDA 1 2025
LIVE
MATHS
PROBABILITY
CLASS 1
SSBCrack EXAMS
NAVJYOTI SIR
Crack EXAMS

RANDOM EXPERIMENT

An experiment is random means that the experiment has more than one possible outcome and it is not possible to predict with certainty which outcome that will be.

Example – (1) Tossing a coin

(2) Throwing a dice

(3) Drawing a card from a pack of well-shuffled cards

OUTCOME AND SAMPLE SPACE

A possible result of a random experiment is called its outcome for example if the experiment consists of tossing a coin twice, some of the outcomes are HH, HT etc.

A sample space is the set of all possible outcomes of an experiment. In fact, it is the universal set S for a given experiment.

The sample space for the experiment of tossing a coin twice is given by

S = {HH, HT, TH, TT} The sample space for the experiment of drawing a card out of a deck is the set of all cards in the deck.

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EVENT

→ An event is a subset of a sample space S.

→ set containing favourable outcomes.

Sample Space, S acts as Universal Set.

For example, the event of drawing an ace from a deck is

A = {Ace of Heart, Ace of Club, Ace of Diamond, Ace of Spade}

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TYPES OF EVENT

IMPOSSIBLE AND SURE EVENT :

ϕ is called an impossible event and S, i.e., the whole sample space is called a sure event.

Example → ① Throwing a dice and getting a number larger than 6.

$(E = \phi)$ (Impossible event)

→ Getting a number less than 7, when a die is rolled.

$(E = S \longrightarrow$ Sample space) (Sure event)

TYPES OF EVENT

SINGLE OR ELEMENTARY EVENT : If an event E has only one sample point of a sample space, i.e., a single outcome of an experiment, it is called a simple or elementary event.

Getting '1' when a die is thrown $\Rightarrow E = \{1\} \Rightarrow n(E) = 1$

Getting 'King of Hearts' when a card is drawn from deck $\Rightarrow E = \{$  $\}$

TYPES OF EVENT

COMPOUND EVENT : If an event has more than one sample point it is called a compound event.

$n(E) > 1$

Eg :

(1) Getting a number more than 3, when a die is rolled.

$E = \{4, 5, 6\}$

(2) Getting a black card (26 cards are black)

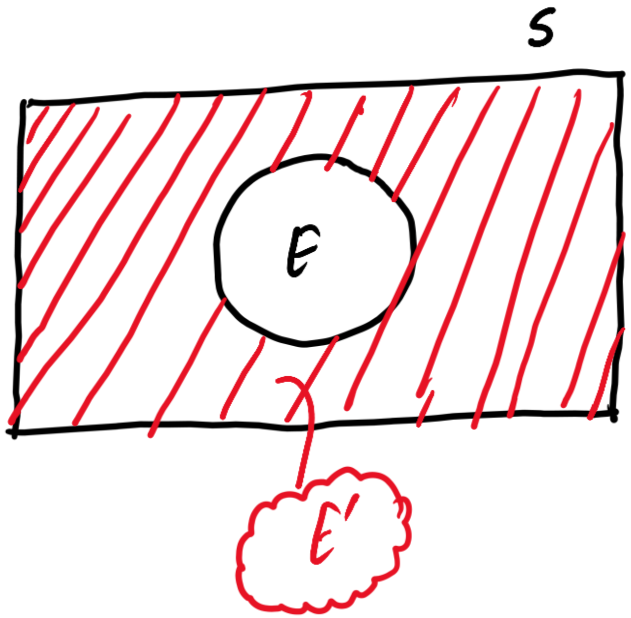
(3) Getting two heads when 3 coins are tossed

$\{HHT, THH, HTH\}$

TYPES OF EVENT

COMPLEMENTARY EVENT : Given an event A, the complement of A is the event consisting of all sample space outcomes that do not correspond to the occurrence of A. The complement of A is denoted by A′ or A^c.

It is also called the event ‘not A’. A′ = A = S – A = $\{w : w \in S \text{ and } w \notin A\}$



Eg : E : Getting a number which is even, when a dice is rolled.

$E = \{2, 4, 6\}$ $S = \{1, 2, 3, 4, 5, 6\}$

$E' = \{1, 3, 5\}$

$(E \cup E' = S)$ $(E' = S - E)$

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EVENT A or B

If A and B are two events associated with same sample space, then the event 'A or B' is same as the event A U B and contains all those elements which are either in A or in B or in both.

$$A \cup B = \{x : x \in A \text{ or } x \in B \text{ or } x \in \text{both}\}$$

all elements of A and B.

Example : E_1 : Getting a number less than 3
E_2 : " a prime number
when a die is rolled.

$E_1 = \{1, 2\}$ $E_2 = \{2, 3, 5\}$ $E_1 \cup E_2 = \{1, 2, 3, 5\}$

(Event E_1 or E_2)

EVENT A and B

If A and B are two events associated with a sample space, then the event 'A and B' is same as the event $A \cap B$ and contains all those elements which are common to both A and B.

(A intersection B $\longrightarrow$ common elements of A & B)

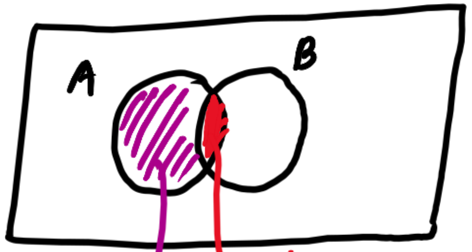
$E_1 = \{1, 2\}$

$E_2 = \{2, 3, 5\}$

$E_1 \cap E_2 = \{2\}$

EVENT A but not B (Difference A – B)

An event A – B is the set of all those elements of the same space S which are in A but not in B, i.e., $A - B = A \cap B'$.



$(A \cap B)$

$A \cap B' = \underline{A - B} = A - \underline{(A \cap B)}$

$E_1 = \{1, 2\}$

$E_2 = \{2, 3, 5\}$

$E_1 - E_2 = \{1\}$

$E_2 - E_1 = \{3, 5\}$

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MUTUALLY EXCLUSIVE EVENTS

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Two events A and B of a sample space S are mutually exclusive if the occurrence of any one of them excludes the occurrence of the other event. Hence, the two events A and B cannot occur simultaneously, and thus $A \cap B = \phi$ **(Also called Pairwise Disjoint)**

Simple or elementary events of a sample space are always mutually exclusive. For example, the elementary events {1}, {2}, {3}, {4}, {5} or {6} of the experiment of throwing a dice are mutually exclusive.

$E_1, E_2, E_3 \ldots E_n$ if $E_i \cap E_j = \phi \; (i \neq j)$ $\Big\}$ $E_1, E_2 \ldots E_n$ are mutually exclusive events.

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EXHAUSTIVE EVENTS

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If $E_1, E_2, ..., E_n$ are n events of a sample space S and if

$$E_1 \cup E_2 \cup E_3 \cup ... \cup E_n = \bigcup_{i=1}^{n} E_i = S$$

then $E_1, E_2, ..., E_n$ are called exhaustive events.

Consider the example of rolling a die. We have S = {1, 2, 3, 4, 5, 6}. Define the two events

A : 'a number less than or equal to 4 appears.' $\rightarrow A = \{1, 2, 3, 4\}$

B : 'a number greater than or equal to 4 appears.' $\rightarrow B = \{4, 5, 6\}$

$A \cup B = \{1, 2, 3, 4, 5, 6\} = S \Rightarrow$ A & B are exhaustive events.

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MUTUALLY EXCLUSIVE AND EXHAUSTIVE EVENTS

If $E_1, E_2, \ldots, E_n$ are n events of a sample space S and if $E_i \cap E_j = \phi$ for every $i \neq j$ i.e., E_i and E_j are pairwise disjoint and $\bigcup_{i=1}^{n} E_i = S$, then the events $E_1, E_2, \ldots, E_n$ are called mutually exclusive and exhaustive events.

Consider the example of rolling a die. Let us define the three events as

A = a number which is a perfect square $\rightarrow \{1, 4\}$

B = a prime number $\rightarrow \{2, 3, 5\}$

C = a number which is greater than or equal to 6 $\rightarrow \{6\}$

$$\left.\begin{array}{l} A \cap B \\ B \cap C \\ C \cap A \end{array}\right\} = \phi$$

$$A \cup B \cup C = \{1, 2, 3, 4, 5, 6\} = S$$

PROBABILITY OF AN EVENT

Let S be the sample space and E be an event, such that n (S) = n and n (E) = m. If each outcome is equally likely, then it follows that

$$P(E) = \frac{m}{n} = \frac{\text{Number of outcomes favourable to E}}{\text{Total number of possible outcomes}}$$

PROBABILITY OF AN EVENT

The probability P is a real valued function whose domain is the power set of S, i.e., P (S) and range is the interval [0, 1] i.e. P : P (S) → [0, 1].

$0 \le P(E) \le 1$

The probability of non occurrence of the event E is denoted by

$$P(\text{not } E) = 1 - P(E)$$

$$\left\{\begin{aligned} A' &= S - A \\ P(A') &= P(S - A) \end{aligned}\right.$$

$$= P(S) - P(A)$$

$$P(A') = 1 - P(A)$$

$$P(E) + P(\text{not } E) = 1$$

If $E_1, E_2 \ldots E_n$ are mutually exclusive as well as exhaustive events under Sample Space S,

$$E_1 \cup E_2 \cup E_3 \ldots E_n = S$$

$$P(E_1) + P(E_2) + \ldots P(E_n) = P(S)$$

$$P(E_1) + P(E_2) + \ldots P(E_n) = 1$$

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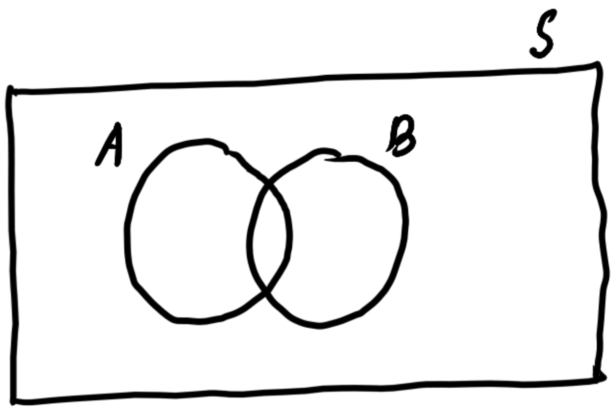
ADDITION RULE

If A and B are any two events in a sample space S, then the probability that atleast one of the events A or B will occur is given by

$$P(A \cup B) = P(A) + P(B) - P(A \cap B)$$



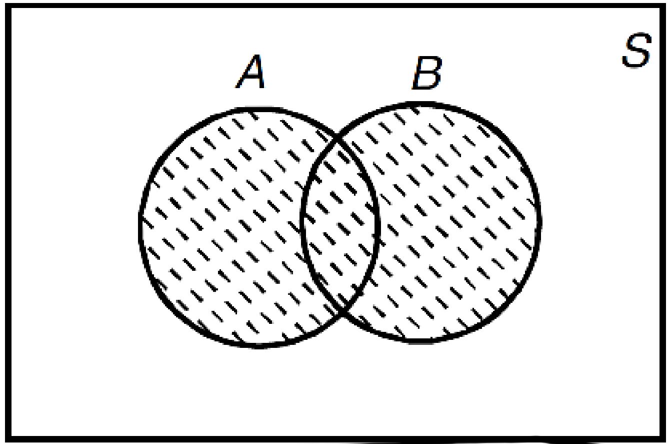
$$n(A \cup B) = n(A) + n(B) - n(A \cap B)$$

VENN DIAGRAM: TYPE 1

We have only two events A and B

1. $P(A \cup B) = P(A) + P(B) - P(AB)$ $(A \cap B)$

(Addition theorem for two events)



$A \cup B$ (Shaded portion)

2. $P(A^c B^c) = 1 - P(A \cup B)$

$A^c \cap B^c = (A \cup B)^c = S - (A \cup B)$

3. $P(A^c B) = P(B) - P(AB)$ $\quad (A^c \cap B = B - (A \cap B)$

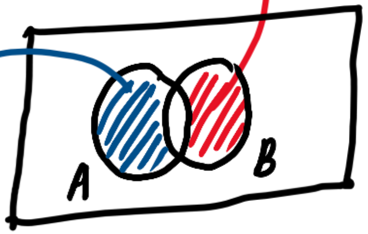
(Probability of occurrence of exactly B event)

4. $P(AB^c) = P(A) - P(AB)$

(Probability of occurrence of exactly A event)

$B - (A \cap B)$

$= B \cap A'$



$A \cap B'$

$(A - (A \cap B))$

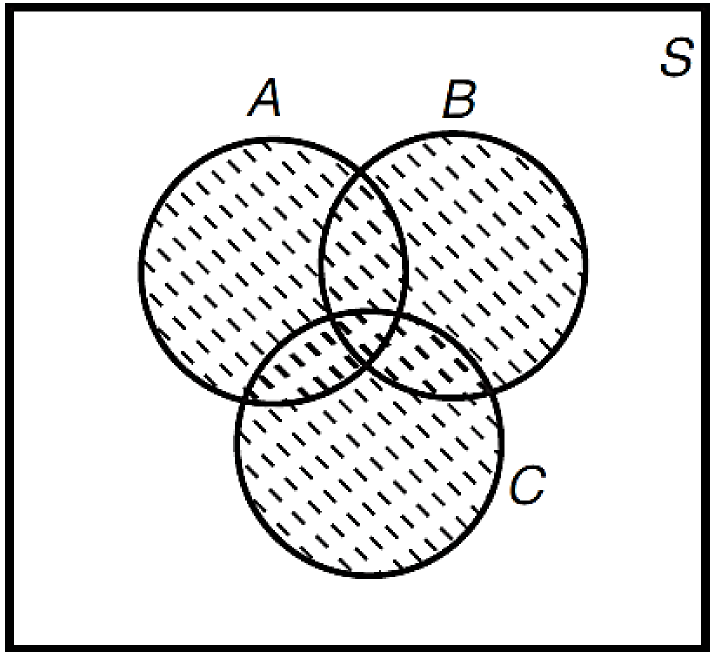
ADDITION RULE

For three events,

$$P(A \cup B \cup C) = P(A) + P(B) + P(C) - P(A \cap B) - P(A \cap C) - P(B \cap C) + P(A \cap B \cap C)$$

VENN DIAGRAM: TYPE 2

When we have three events A, B and C



Shaded region : $A \cup B \cup C$

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VENN DIAGRAM: TYPE 2

1. $P(A \cup B \cup C) = P(A) + P(B) + P(C)$
$- P(\underline{AB}) - P(\underline{BC}) - P(\underline{CA}) + P(\underline{ABC})$
(Addition theorem for three events)

$\underline{AB = A \cap B}$

2. If A, B and C are mutually exclusive events, then
$P(A \cup B \cup C) = P(A) + P(B) + P(C)$ $\}$ $A \cap B = B \cap C = C \cap A = A \cap B \cap C = \phi,$
3. If A, B and C are mutually exclusive and exhaustive events, then $\underline{P(A) + P(B) + P(C) = 1}$.

QUESTION

Suppose that each child born is equally likely to be a boy or a girl. Consider a family with exactly three children.

Write each of the following events as a set and find its probability :

(i) The event that exactly one child is a girl.

(ii) The event that at least two children are girls

(iii) The event that no child is a girl

GGG

BBB — (iii)

GBB — ✓

GGB

BGG

BBG — ✓

GBG

BGB — ✓

(i) $\frac{3}{8}$

(ii) atleast → minimum ⇒ 2 girls + 3 girls

$\frac{4}{8} = \frac{1}{2}$

(iii) $\frac{1}{8}$ //

QUESTION

What is the probability that a randomly chosen two-digit positive integer is a multiple of 3?

$10, 11, 12, 13, 14 \ldots 99$

$$\text{Probability} = \frac{30}{90} = \frac{1}{3}$$

$12, 15, 18 \ldots 99$ (AP)

$$99 = 12 + (n-1)(3)$$

$$n = \frac{87}{3} + 1$$

$$n = 29 + 1 = 30$$

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QUESTION

In a leap year the probability of having 53 Sundays or 53 Mondays is

(A) $\frac{2}{7}$ (B) $\frac{3}{7}$ (C) $\frac{4}{7}$ (D) $\frac{5}{7}$

$\underline{52 \text{ weeks}} = 52 \times 7 = \underline{364 \text{ days} + 2 \text{ days}} = 366$ days (Leap year)

every year

(Sun, Mon), (Mon, Tue), (Tue, Wed), (Wed, Thur),

(Thur, Fri), (Fri, Sat), (Sat, Sun)

$\frac{2}{7}$

EXAMPLE

Let A and B be the two possible outcomes of an experiment and $P(A) = 0.4, P(B) = x$ and $P(A \cup B) = 0.7$. What is value of x, the events A and B are mutually exclusive?

(a) 0.3 (b) 0.2

(c) 0.5 (d) 0.7

if A & B are mutually exclusive ; $P(A \cap B) = 0$

$$P(A \cup B) = P(A) + P(B)$$

$$0.7 = 0.4 + P(B)$$

$$P(B) = 0.3$$

EXAMPLE

Let A and B be the two possible outcomes of an experiment and $P(A) = 0.4, P(B) = x$ and $P(A \cup B) = 0.7$. What is value of x, the events A and B are mutually exclusive?

(a) 0.3 (b) 0.2

(c) 0.5 (d) 0.7

Ans: (a)

Consider A and B are two non-mutually exclusive events.

If $P(A) = \frac{1}{4}$, $P(B) = \frac{2}{5}$ and $P(A \cup B) = \frac{1}{2}$,

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Q) The value of $P(A \cap B)$ is

(a) $\frac{4}{13}$

(b) $\frac{3}{20}$

(c) $\frac{3}{43}$

(d) None of these

If $P(A) = \frac{1}{4}$, $P(B) = \frac{2}{5}$ and $P(A \cup B) = \frac{1}{2}$,

$$P(A \cup B) = P(A) + P(B) - P(A \cap B)$$

$$\frac{1}{2} = \frac{1}{4} + \frac{2}{5} - x$$

$$x = \frac{1}{4} + \frac{2}{5} - \left(\frac{1}{2}\right) = \frac{5 + 8 - 10}{20} = \frac{3}{20}$$

Q) The value of $P(A \cap B)$ is

(a) $\frac{4}{13}$

(b) $\frac{3}{20}$

(c) $\frac{3}{43}$

(d) None of these

Ans: (b)

Q) The value of $P(A \cap B')$ is

(a) $\frac{1}{10}$

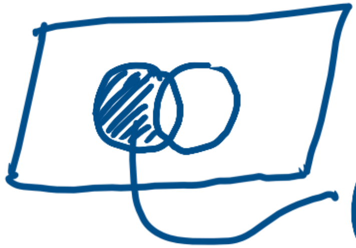
(b) $\frac{2}{13}$

(c) $\frac{1}{5}$

(d) None of these

If $P(A) = \frac{1}{4}$, $P(B) = \frac{2}{5}$ and $P(A \cup B) = \frac{1}{2}$,

$A \cap B' = A - (A \cap B)$



$(A - A \cap B)$

$P(A \cap B') = P\left(A - (A \cap B)\right)$

$= P(A) - P(A \cap B) = \frac{1}{4} - \frac{3}{20} = \frac{5-3}{20} = \frac{2}{20} = \frac{1}{10}$

Q) The value of $P(A \cap B')$ is

(a) $\frac{1}{10}$

(b) $\frac{2}{13}$

(c) $\frac{1}{5}$

(d) None of these

Ans: (a)

If $P(A) = \frac{1}{4}$, $P(B) = \frac{2}{5}$ and $P(A \cup B) = \frac{1}{2}$,

Q) The value of $P(A' \cap B')$ is

(a) $\frac{1}{3}$

(b) $\frac{1}{2}$

(c) $\frac{1}{5}$

(d) None of these

$$P(A' \cap B') = P(A \cup B)'$$

$$= 1 - P(A \cup B)$$

$$= 1 - \frac{1}{2} = \frac{1}{2}$$

$$P(A') = 1 - P(A)$$

(not A)

Q) The value of $P(A' \cap B')$ is

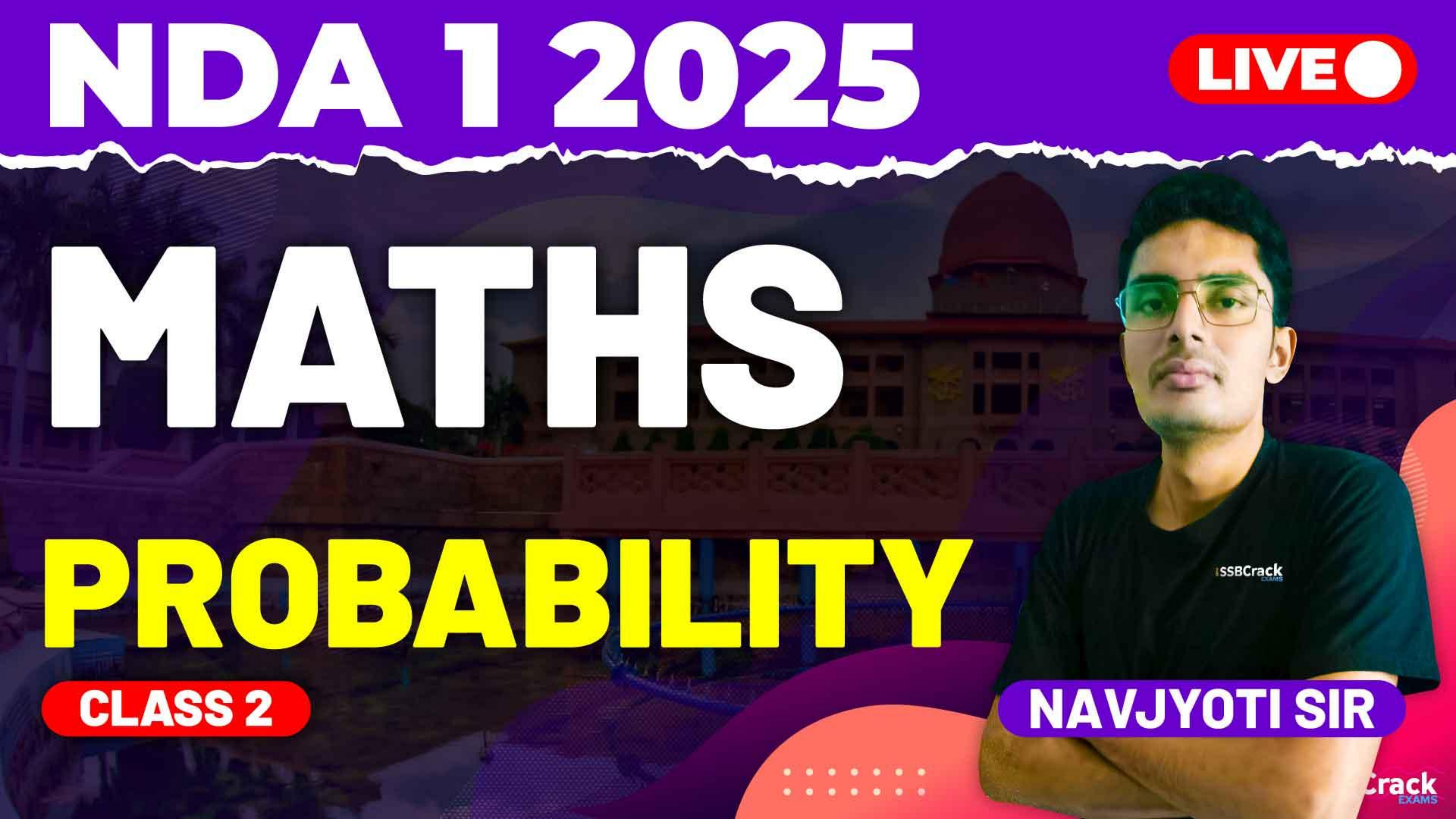
(a) $\frac{1}{3}$

(b) $\frac{1}{2}$

(c) $\frac{1}{5}$

(d) None of these

Ans: (b)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