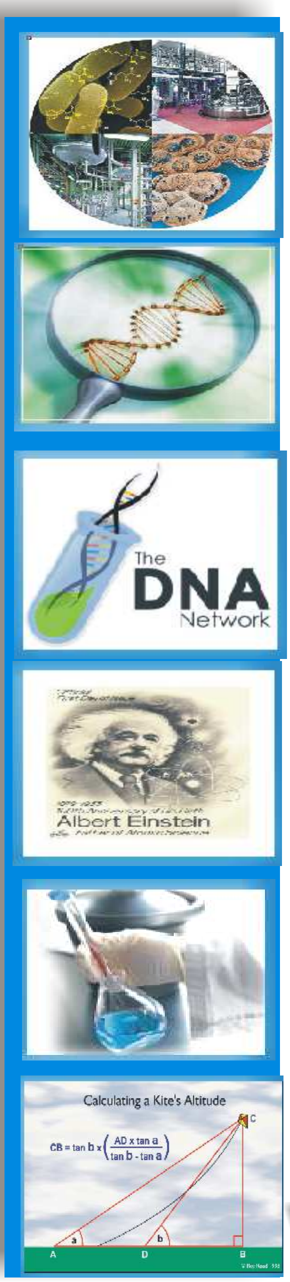


# MAH-MCA

## SAMPLE THEORY

- BINARY CODED DECIMAL (BCD)
- LIMITS

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## 1. BINARY CODED DECIMAL (BCD)

In this coding system, the weight are assigned to the binary bits according to their position. The weight in the BCD codes are 8, 4, 2, 1. For example.

The bit assignment 0110, can be represented by weight to represent the decimal 6 because

$$0 \times 8 + 4 \times 1 + 2 \times 1 + 1 \times 0 = 6$$

The 8421 BCD codes is given in table below.

| 8421(BCD) | Decimal |
|---|---|
| 0000 | 0 |
| 0001 | 1 |
| 0010 | 2 |
| 0011 | 3 |
| 0100 | 4 |
| 0101 | 5 |
| 0110 | 6 |
| 0111 | 7 |
| 1000 | 8 |
| 1001 | 9 |

**CONVERSION FROM DECIMAL TO BCD**

Each digit of decimal number is replaced by its corresponding 4 digit BCD code. For example-

$(1472)_{10} = (0001\ 0100\ \ 0111\ 0010)_{8421}$

$(1)_{10} = (0\ 0\ 0\ 1)_{8421}$

$(4)_{10} = (0\ 1\ 0\ 0)_{8421}$

$(7)_{10} = (0\ 1\ 1\ 1)_{8421}$

$(2)_{10} = (0\ 0\ 1\ 0)_{8421}$

**CONVERSION FROM BCD TO DECIMAL**

Make a group of 4 bits from left to right and replace it by its corresponding decimal digital according to BCD table given above.

**EXCESS-3 CODE**

This is an unweighted code, its code assignment is obtained from the corresponding value of BCD after the addition of 3 or the excess-3 can be derived by adding three (3) to decimal digit and then converting the result to four bit binary.

For example: The excess-3 code for decimal 2 and 9 are -

$$\begin{array}{r} 2 \\ \underline{+3} \\ 5 = (0101) \end{array} \qquad \begin{array}{r} 9 \\ \underline{+3} \\ 12 \rightarrow (1100) \end{array}$$

Table below show the excess-3 code for each decimal digit, with their BCD equivalent.

| Decimal | BCD | Excess – 3 |
|---|---|---|
| 0 | 0000 | 0011 |
| 1 | 0001 | 0100 |
| 2 | 0010 | 0101 |
| 3 | 0011 | 0110 |
| 4 | 0100 | 0111 |
| 5 | 0101 | 1000 |
| 6 | 0110 | 1001 |
| 7 | 0111 | 1010 |
| 8 | 1000 | 1011 |
| 9 | 1001 | 1100 |

**EX.1.** The decimal number 241 is represented in Binary Coded Decimal System as

(A) 1001001000 (B) 1000100010

(C) 1001000001 (D) 001001000001

**SOL. (D)**

2 → 0010, 4 → 0100, 1 → 0001

**Ex.2.** 3428 is the decimal value for which of the following binary coded decimal (BCD)grouping ?

(A) 11010001001000 (B) 11010000101000

(C) 01101001000010 (D) 110100001101010

**SOL.(B)** 0011 0100 0010 1000

$$\underbrace{0011}_{3}\ \underbrace{0100}_{4}\ \underbrace{0010}_{2}\ \underbrace{1000}_{8}$$

So, option (B) is correct.

**2. LIMITS**

**Definition of limit**

The number A is said to be the limit of f(x) at x = a if for only arbitrarily chosen positive number ε, however small but not zero, there exists a corresponding number δ greater than zero such that $|f(x) - A| < \varepsilon$ For all values of x for which

$0 < |x - a| < \delta$ where $|x - a|$ means the absolute value of x – a without any regard to sign.

**Right hand and left hand limits**

If x approaches a from the right, that is, from larger values of x than a, the limit of f as defined before is called the right hand limit of f(x) and is written as $\lim_{x \to a+0} f(x)$ or f(a + 0)

The working rule for finding the right hand limit is:- "Put a + h for x in f(x) and make h approach zero". In short, we have

f(a + 0) = $\lim_{h \to 0} f(a+h)$ Similarly if x approaches a from the left, that is, from smaller values of x than a, the limit of f is called the left hand and is written as or f(a – 0). In this case, we have f(a – 0) = $\lim_{h \to 0}$ (a – h). If both right hand and left hand limits of f(x), as $x \to a$, **exist are equal in value,** their common value, evidently, will be the limit of f(x) as $x \to a$. If, however, either or both of these limits do not exist, the limit of f(x) as $x \to a$ does not exist. Even if both these limits exist but are not equal in value then also the limit of f(x) as $x \to a$ does not exist.

**Algebra of Limits**

$$\operatorname*{Lt}_{x \to a} [f(x) \pm g(x)] = \operatorname*{Lt}_{x \to a} f(x) \pm \operatorname*{Lt}_{x \to a} g(x) \quad \operatorname*{Lt}_{x \to a} [f(x) g(x)] = \operatorname*{Lt}_{x \to a} f(x) . \operatorname*{Lt}_{x \to a} g(x)$$

$$\operatorname*{Lt}_{x \to a} \frac{f(x)}{g(x)} = \operatorname*{Lt}_{x \to a} f(x) \div \operatorname*{Lt}_{x \to a} g(x) \text{ provided } \operatorname{Lt} g(x) \neq 0$$

**1. Indeterminate forms and L'Hospital's Rule**

If a function f(x) takes the form $\frac{0}{0}$ at x = a, then we say that f(x) is indeterminate at x = a.

Other indeterminate forms are $\infty/$, $\infty-\infty$, $0\times\infty$, $1^{\infty}$, $0^{0}$, $\infty^{0}$

**L'Hospital's Rule** If $\phi$(x) and $\psi$(x) are functions of x such that $\phi$(a) = 0 and $\psi$(a) = 0, then

$$\lim_{x\to a}\frac{\phi(x)}{\psi(x)}=\lim_{x\to a}\frac{\phi'(x)}{\psi'(x)}.$$

**Important Note** While applying L'Hospital's rule, we are not to differentiate $\frac{\phi(x)}{\psi(x)}$ by the rule for finding the differential coefficient of the quotient of two functions. But we are to differentiate the numerator and denominator separately.

**2. Limits of algebraic expressions**

**When** $N^r$ **and** $D^r$ **have same degree** = $\underset{x\to 0}{\text{Lt}}$ ratio of their constant terms $\underset{x\to\infty}{\text{Lt}}$ = ratio of the coefficients of highest powers of x, This is obtained by putting x = $\frac{1}{y}$ and as $x\to\infty$, $y\to 0$

$$\underset{x\to 0}{\text{Lt}}\frac{2x^2+5x+7}{3x^2+2x-3}=\frac{7}{-3},\ \underset{x\to\infty}{\text{Lt}}\frac{\alpha x^2+5x+7}{3x^2+2x-3}=\frac{2}{3}$$

**3. Certain Limits**

For indeterminate forms we can find the limit by L'Hospital's rule. Besides this, we should use expansions of various functions given above or else apply algebra of limits given above. The following limits should be remembered:-

$\underset{x\to 0}{\text{Lt}}\frac{\sin x}{x}$ = 1. In other words sinx = x when x is very small and so also tanx = x whereas cosx = 1 when x is small.

$\frac{\sin x}{x}$ $\frac{a^x - 1}{x}$ = loga $\quad \underset{x\to 0}{\text{Lt}} (1+x)^{\frac{1}{x}}$ = e or $\underset{x\to\infty}{\text{Lt}} \left(1+\frac{1}{x}\right)^x$ = e and $\underset{x\to 0}{\text{Lt}} (1+px)^{\frac{1}{x}}$ = $e^p$

or $\underset{x\to\infty}{\text{Lt}} \left(1+\frac{p}{x}\right)^x$ = $e^p$

or $\underset{x\to 0}{\text{Lt}} \left(1+\frac{x}{p}\right)^{\frac{1}{x}} = e^{\frac{1}{p}}$ $\quad$ or $\underset{x\to\infty}{\text{Lt}} \left(1+\frac{1}{px}\right)^x = e^{\frac{1}{p}}$

**Ex.1.** $\lim_{x\to 0}(1+2x)^{\frac{1}{3x}}$ =

(A) $e^{3/2}$ (B) $e^{1/3}$ (C) $e^{2/3}$ (D) $e^{-1}$

**SOL.(C)** Let A = $\lim_{x\to 0}(1+2x)^{\frac{1}{3x}}$

$\therefore$ log A = $\lim_{x\to 0}\frac{\log(1+2x)}{3x}$ $\left[\text{from}\frac{0}{0}\right]$

$= \lim_{x\to 0}\frac{2}{3.(1+2x)}$

[By De L' Hospital rule]

$= \frac{2}{3(1+0)} = \frac{2}{3}$

$\Rightarrow$ A = $e^{2/3}$

**Ex.2** $\lim_{x\to 0}\left(\frac{\log x^2}{\cot x^2}\right)$ is equal to

(A) 1 (B) 2 (C) 0 (D) $\frac{1}{2}$

**SOL.(C)** $\lim_{x\to 0}\left(\frac{\log x^2}{\cot x^2}\right) = \lim_{x\to 0}\frac{2/x}{-\text{cosec}^2 x^2 . 2x}$ [By De L' Hospital rule]

$= \lim_{x\to 0}\frac{-\sin^2 x^2}{x^2} = \lim_{x\to 0} -x^2 \times \left(\frac{\sin x^2}{x^2}\right)^2 = 0 \times 1 = 0$