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Group Homomorphism

Definition : Let (G, *) and (G`, #) are two groups. A mapping f from G to G` is said to homomorphism

if $f(a * b) = f(a) \# f(b)$; for all $a, b \in G$.

Q.1. Let G be a non-abelian group, $y \in G$ and let the maps f, g, h from G to itself be defined by

$f(x) = yxy^{-1}$, $g(x) = x^{-1}$ & $h = g \circ g$. Then

(a) g and h are homomorphism and f is not a homomorphism.

(b) h is homomorphism & g is not a homomorphism.

(c) f is homomorphism & g is not a homomorphism.

(d) f, g & h are homomorphism.

Q.2. Which of the following condition on a group G implies that G is abelian?

(a) The order of G is p^3 for some prime p

(b) Every proper subgroup of G is cyclic.

(c) Every subgroup of G is normal in G.

(d) The function $f : G \to G$ defined by $f(x) = x^{-1}$ for all $x \in G$ is a homomorphism.

Kernel of homomorphism : Let $f: G \to G'$ be a homomorphism then the set $k = \{x \in G; f(x) = e', \text{where } e' \text{ is identity of } G'\}$ is called kernel of homomorphism.

One-one homomorphism : Let $f : G \to G`$ be a homomorphism and ker f is kernel of f, then f is called one – one homomorphism if ker (f) = e.

Another definition : Let $f : G \to G`$ be a homomorphism, then it is called one-one homomorphism if $m_1 \neq m_2 \Rightarrow f(m_1) \neq f(m_2)$

Note :

(1) ker(f) is a subgroup of G.

(2) ker(f) is normal subgroup of G.

Image/Range of a homomorphism :

Let $f : G \to G`$ be a homomorphism then $f(G) = \{T(x) \mid x \in G\}$ is called range/image of homomorphism.

Onto Homomorphism : Let $f : G \to G`$ be a homomorphism and it is called onto homomorphism if $f(G) = G`$

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Definition : Let G and G` be any two groups, then

1. An onto homomorphism from a group G to another group G` is called Epimorphism.
2. A one-one homomorphism from a group G to another group G` is called Monomorphism.
3. A homomorphism from group G to itself is called Endomorphism.
4. A one-one and onto homomorphism from a group G to another group G` is called Isomorphism.
5. A one-one and onto homomorphism from a group G to itself is called Automorphism.

Basic Properties of Homomorphism

1. $f(e) = e'$, where e and e` are identity elements of G and G` respectively.

2. $f(x^{-1}) = (f(x))^{-1}$, for all $x \in G$

3. $f(x^n) = (f(x))^n$ for all $x \in G, n \in Z$

4. Let $f : G \to G'$ be a homomorphism, then ker f is a normal subgroup of G.

Fundamental Theorem of Homomorphism :

Let $f : G \to G'$ is a onto homomorphsim from G to G` if ker(f) is a kernel of f, then

$$\frac{G}{\ker(f)} \approx f(G) \approx G'$$

$$\Rightarrow \quad \frac{G}{\ker(f)} \approx G'$$

Note : Let f : G $\rightarrow$ G` is a group homomorphism then $\frac{G}{\ker(f)}$ is a subgroup of G` because $\frac{G}{\ker(f)} \approx f(G)$ & f(G) is a subgroup of G`, then $O\left[\frac{G}{\ker(f)}\right] \Big| O(G`)$.

Q.3. Let $f : Z_{14} \to Z_{10}$ be a homomorphism with $O(\ker f) = 7$ then order of range set of f is

(a) 1 (b) 2

(c) 5 (d) 10

Q.4. Let $f : Z_{10} \to Z_8$ be a homomorphism then which of the following possible order for Kernal of f

(a) 2 (b) 5

(c) 8 (d) 1

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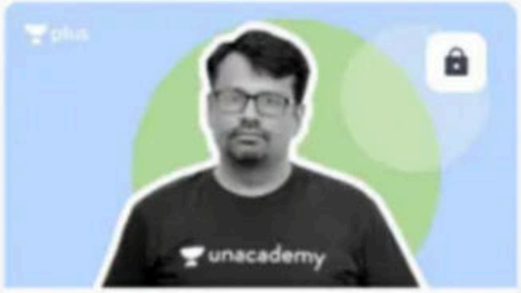

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Educator highlights

- Works at **Pacific Science College**
- Studied at **M.Sc., NET, PhD(Algebra), MBA(Finance), BEd**
- PhD, NET | Plus Educator For CSIR NET | Youtuber (260K+Subs.) | Director Pacific Science College |
- Lives in **Udaipur, Rajasthan, India**
- Unacademy Educator since

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