Practical No : 2.5
Cosets and Lagrange's Theorem
Objective Questions

(1) Let H be a subgroup of G and $a \in G$. $aH = H$ if and only if

(a) $a \notin H$ (b) $a \in H$

(c) $a^{-1} \notin H$ (d) None of these

(b) $a \in H$

(2) Let H be a subgroup of G and $a, b \in G$. $aH = bH$ if and only if

(a) $a \in H$ (b) $ab \in H$

(c) $a^{-1}b \in H$ (d) None of these

$$aH = bH \Rightarrow a^{-1}(aH) = a^{-1}(bH)$$
$$\Rightarrow (a^{-1}a)H = (a^{-1}b)H$$
$$\Rightarrow eH = (a^{-1}b)H$$
$$\Rightarrow a^{-1}b \in H$$

(3) Let H be a subgroup of G and $a, b \in G$. If $aH \neq bH$ then

(a) $aH \cap bH = \phi$ (b) $aH \cap bH \neq \phi$

(c) $aH \subset bH$ (d) None of these

(a) $aH \cap bH = \phi$

(4) Let H be a subgroup of G . Which of the following statements are true

(i) $a \notin aH$

(ii) $|aH| = |bH| \quad \forall a, b \in G$

(iii) $aH = Ha$ if and only if $H = aHa^{-1}$

(a) (i) and (ii) (b) (ii) and (iii)

(c) (i) and (iii) (d) Only (ii)

(b) (ii) & (iii) $aH = Ha$

(b) (ii) & (iii) $aH = Ha$

$aHa^{-1} = Haa^{-1} = H(aa^{-1}) = H$

(5) Let $G = \mathbb{Z}$ and $H = 5\mathbb{Z}$. Then the following pair of left cosets are not equal. Then

(a) $11 + 5\mathbb{Z}$ and $-39 + 5\mathbb{Z}$. ✓(b) $11 + 5\mathbb{Z}$ and $-25 + 5\mathbb{Z}$

(c) $11 + 5\mathbb{Z}$ and $-34 + 5\mathbb{Z}$. (d) None of these.

$G = \mathbb{Z}$, $H = 5\mathbb{Z} = \{\cdots -15, -10, -5, 0, 5, 10, 15 \cdots\}$

$11 + 5\mathbb{Z} = \{\cdots -4, 1, 6, 11, 16, 21, 26 \cdots\}$

$-39 + 5\mathbb{Z} = \{\cdots -54, -49, -44, -39, -34, -29 \cdots\}$

$-25 + 5\mathbb{Z} = 5\mathbb{Z}$

(6) Let H be a subgroup of G and $a \in G$. aH is a subgroup of G if and only if

(a) $a \notin H$ ✓(b) $a \in H$

(c) $a^{-1} \notin H$ (d) None of these

(b) $a \in H$

(7) If $G = \mathbb{Z}$ with addition and $H = \{0, \pm 3, \pm 6, \pm 9, \dots\}$ then which of the following is true

✓(a) $11 + H = 17 + H$ ✓(b) $11 + H = 17 + H$

(c) $7 + H = 23 + H$ (d) $H = 2 + H$

$11 + H = \{\cdots +2, 5, 8, 11, 14, 17, 20 \cdots\}$

$17 + H = \{\cdots +8, 11, 14, 17, 20 \cdots\}$

$11 + H = 17 + H$

(8) The left cosets of $H = \{1,11\}$ in $U(30)$ are

✓(a) $7 + H, 13 + H, 19 + H, 11 + H$ (b) $7 + H, 13 + H, 23 + H$

(c) $H, 1 + H, 29 + H$ (d) None of these

$H = \{1, 11\}$, $U(30) = \{1, 7, 11, 13, 17, 19, 23, 29\}$

$1 + H = H$,

$7 + H = \{7, 18\}$ ✓ | $17 + H = \{18, 7\}$

$11 + H = \{12, 22\}$ ✓ | $19 + H = \{20, 0\}$ ✓

$13 + H = \{14, 24\}$ ✓ | $23 + H = \{24, 14\}$

$29 + H = \{0, 20\}$

(9) Suppose a has order 20, then number of cosets of $< a^5 >$ in $< a >$ is

(a) 3 ✓(b) 5

(c) 4 (d) None of these

$$\langle a \rangle = \{ a, a^2, a^3, a^4, \dots a^{19}, a^{20} = e \}$$
$$\langle a^5 \rangle = \{ a^5, a^{10}, \underset{a^{15}}{a^{20}} = e \} = \{ a^5, a^{10}, a^{15}, e \}$$
$$a \langle a^5 \rangle = \{ a^6, a^{11}, a^{16}, a \}$$
$$a^2 \langle a^5 \rangle = \{ a^7, a^{12}, a^{17}, a^2 \}$$
$$a^3 \langle a^5 \rangle = \{ a^8, a^{13}, a^{18}, a^3 \}$$
$$a^4 \langle a^5 \rangle = \{ a^9, a^{14}, a^{19}, a^4 \}$$
$$a^5 \langle a^5 \rangle = \langle a^5 \rangle$$

(10) Let $G = \mathbb{C}^*$ under multiplication and $H = \{z \in \mathbb{C}^* : |z| = 1\}$, then cosets of H in G are

✓(a) $\{z \in \mathbb{C}^* : |z| = k\}\ \forall k \in \mathbb{R}^+$ (b) $\{z \in \mathbb{C}^* : |z.w| = 1\}\ \forall w \in \mathbb{C}^*$

(c) $\{z \in \mathbb{C}^* : |z + w| = 1\}\ \forall w \in \mathbb{C}^*$ (d) None of these

$$H = \{ z \in \mathbb{C}^*, |z| = 1 \} = \{ a+ib,\ a^2+b^2 = 1,\ a \neq 0 \text{ or } b \neq 0 \}$$
$$(x+iy)H = \{ (x+iy)(a+ib), |z.\omega| = 1$$
$$= (xa - yb) + i(ya + xb)$$
$$\text{Mod} = \sqrt{(xa-yb)^2 + (ya+xb)^2}$$
$$= \sqrt{x^2a^2 - \cancel{2xayb} + y^2b^2 + y^2a^2 + \cancel{2xyab} + x^2b^2}$$
$$= \sqrt{(x^2+y^2)(a^2+b^2)} = \sqrt{x^2+y^2}$$

(11) Let K be a proper subgroup of H and H be proper subgroup of G. If $|K| = 42$ and $|G| = 420$, what are the possible orders of H?

✓(a) 84, 210 (b) Only 84

(c) Only 210 (d) None of these

$$|K| = 42, \quad |G| = 420$$
$$42 \mid 84$$
$$42 \mid 210$$

(12) If $G = \mathbb{Z}_{17}$ then how many solutions does $x^{16} = \bar{1}$ has in G

(a) 16 (b) 15

✓(c) 17 (d) None of these

$x^{16} = I$ but $(17, 16) = 1$

$\therefore$ No. of soln $= 17$

(c)

(13) If $G = GL(2, \mathbb{R})$ and $H = SL(2, \mathbb{R})$ then for any matrix A in G, the coset AH is

✓(a) The set of all 2 X 2 matrices with the same determinant as A

(b) The set of all 2 X 2 matrices with determinant equal to 1

(c) The set of all 2 X 2 matrices with determinant equal to -1

(d) None of these

$G = \left\{ \begin{pmatrix} a & b \\ c & d \end{pmatrix}, \det\begin{pmatrix} a & b \\ c & d \end{pmatrix} \neq 0 \right\}$

$H = \left\{ \begin{pmatrix} a & b \\ c & d \end{pmatrix} \quad \det\begin{pmatrix} a & b \\ c & d \end{pmatrix} = 1 \right\}$

$A \in G, \quad B \in H, \quad \det B = 1$

$AH = \{ AB, \quad \det(AB) = \det A . \det B = \det A \}$

(14) If G is a non-abelian group of order 10 then G has how many elements of order 2

✓(a) 5

(b) 6

(c) 4

(d) None of these

> If G is a non-abelian group of order 10, prove that G has five elements of order 2.

I know that if $a \in G$ such that $a \neq e$, then as a consequence of Lagrange's theorem $|a| \in \{2, 5, 10\}$. The order of a cannot equal 10, since then G would be cyclic, and thus abelian which is a contradiction. Now this means that $|a| = 2$ or $|a| = 5$. I know from this question that G has a subgroup of order 5. This subgroup H has prime order, so it is cylic, and all of its non-identity elements have order 5. Now I need to show that the elements not in H have order 2. This is where I'm stuck.

I've tried assuming that an element $b \notin H$ has order 5, in order to derive a contradiction, but to no avail.

I also know from a previous exercise that if G has order 10, then it has at least one subgroup of order 2, so I tried to assume toward a contradiction that G has two subgroups of order 5, and one subgroup of order 2. I was trying to show that this would make G abelian, but I couldn't.

(15) Order of $U(n)$ for $n > 2$ is

(15) Order of U(n) for $n > 2$ is

(a) Even (b) Odd

(c) n-1 (d) None of these

$U(3) = \{1, 2\}$
$U(4) = \{1, 3\}$
$U(5) = \{1, 2, 3, 4\}$

(16) H and K be a subgroups of a group G. If $|H| = 12$ and $|K| = 35$. Find $|H \cap K|$

(a) 2 (b) 1

(c) 3 (d) None of these

 # 7.20: Since H and K are both subgroups of G, we know that $H \cap K$ must contain e, so it is nonempty. Suppose there is some other element, g, that is in $H \cap K$. Then $g \in H$ and $g \in K$, so $|g| > 1$ must divide the order of H and of K, since both H and K are themselves groups. But, since $|H| = 12$ and $|K| = 35$ have no common divisors greater than 1, we have derived a contradiction. Thus, the only element in $H \cap K$ is e, so $|H \cap K| = 1$.

(17) Let G be a group of order 25. Which of the following is true

(a) G is cyclic (b) $g^5 = e$ for all g in G

(c) G is cyclic or $g^5 = e$ for all g in G (d) None of these

If G is a group of order 25 then either G is cyclic or $g^5 = e$ for all g in G.

Solution.

If G is cyclic, then we're done. So assume that G is not cyclic. Let $g \in G$. If $g = e$, then clearly $g^5 = e$. So suppose $g \neq e$. Then $|g|$ divides 25, *i.e.*, $|g| = 1, 5$, or 25. But $|g| \neq 1$ since we assumed $g \neq e$, and $|g| \neq 25$ since otherwise, G would be cyclic. So $|g| = 5$, *i.e.*, $g^5 = e$.

(19) Let $|G| = 8$ then

(a) G must have an element of order 2

(b) G must have an element of order 4

(c) G may not have an element of order 2

(d) None of these

(a) G must have an element of order 2

(20) Which of the following is true

(a) Every odd ordered subgroup of D_n is cyclic

(b) Every subgroup of D_n is cyclic

(c) Only one subgroup of D_n is cyclic

(d) None of these

Prove that any subgroup of D_n of odd order is cyclic.

So far I have:
Let $H \leq D_n$
Let r denote a simple rotation such that $r^n = e$, and let f denote a vertical flip
if $|H| = 1$, we're done since $H = e$, which is cyclic
otherwise let $|H| = 2k + 1$ for some non-negative $k \in \mathbb{N}$

Consider $a \in H$.
If $a = r^m * f$ for some $m \in \mathbb{Z}$, then $ord(a) = 2$. Since the order of any element must divide the order of the group, we have that a cannot be in H.

So the only elements of H are of the form r^m.

But I can't seem to show that H must be generated by an element of the form r^m. Any help would be greatly appreciated.

(21) Let $G = S_3$ and consider the subgroup $H = \{I, (12)\}$ of G. Then

(a) Every left coset of H in G is also a right coset.

(b) $[G: H] = 3$ and two left cosets of H in G are also right cosets.

(c) No left coset except H itself is a right coset of H in G.

(d) None of the above.

$S_3 = \{I, (12), (13), (23), (123), (132)\}$

$H = \{I, (12)\}$

$(13)H = \{(13), (123)\}$ | $H(13) = \{(13), (132)\}$

$\therefore \quad IH = HI$

$\therefore \quad IH = HI$

$(12)H = H(12)$

(22) Suppose G has subgroups of order 45 and 75. If $|G| < 400$, then $|G|$ is

(a) 90 (b) 150

(c) 225 ✓ (d) None of this

$|G| < 400$, $O(H) = 45$, $O(K) = 75$

H & K are subgroup

$45 \mid 225$, $75 \mid 225$

(23) Let G be an abelian group of order 12. If $a, b \in G$ and order of a is 4 and order of b is 6 then order of ab is

(a) 2 (b) 4

(c) 6 (d) 12 ✓

$O(ab) = \text{lcm}\{O(a), O(b)\}$

$= \text{lcm}\{4, 6\}$

$2 \mid 4, 6$

$\ 2, 3$

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Objectives

(1) Let $\varphi: C^* \to C^*$ given by $\varphi(x) = x^4$ be a homomorphism then $ker\varphi =$

(a) $\{1, -1\}$ (b) $\{1, -1, i, -i\}$ ✓

(c) $\{i, -i\}$ (d) None of these

$\ker \phi = \{x \in C^*, \ \phi(x) = 1\}$

$x^4 = 1$

$= \{1, -1, i, -i\}$

26-04-2021

(2) Let $\varphi: \mathbb{Z}_{12} \to Z_{12}$ given by $\varphi(x) = 3x$ be a homomorphism then $ker\varphi =$

(a) $\{\bar{0}, \bar{1}\}$ (b) $\{\bar{0}, \bar{4}, \bar{8}\}$ ✓

(c) $\{\bar{0}, \bar{4}\}$ (d) None of these

$\phi(x) = 3x$, $\ker \phi = \{x \in \mathbb{Z}_{12}, \ \phi(x) = \bar{0}\}$

$\phi(\bar{1}) = 3 \times 1 = 3 \not\equiv 0 \pmod{12}$

(b) $\quad \phi(\bar{4}) = 12 \equiv 0 \pmod{12}$

$\phi(\bar{8}) = 24 \equiv 0 \pmod{12}$

(3) Number of homomorhisms from $\mathbb{Z}_{12}$ to $\mathbb{Z}_{30}$ is

(a) 6 ✓ (b) 7

(c) 8 (d) None of these

$(12, 30) = 6$

$12 \overline{)30} (2$
24
$6 \overline{)12} (2$
12
$\times$

(4) Let G be a cyclic group of order 7 and $\varphi: G \to G$ given by $\varphi(x) = x^4$ then

(a) φ is not a group homomorphism

(b) ✓ φ is a group homomorphism which is not one-one

(c) φ is a group homomorphism which is not onto

(d) None of these

$G = \langle a \rangle, \quad a^7 = e$

(b) $\phi(x) = x^4, \quad \phi(y) = y^4$

$\phi(xy) = (xy)^4 = x^4 y^4 = \phi(x)\phi(y)$

$\ker \phi = \{ x \in G \mid \phi(x) = 1 \}$
$x^4 = 1$

(5) Suppose $\varphi: \mathbb{Z}_{30} \to Z_{30}$ is a group homomorphism and $ker\varphi = \{\overline{0}, \overline{10}, \overline{20}\}$. If $\varphi(\overline{23}) = \overline{9}$then the elements that map to $\overline{9}$ are

(a) ✓ $\overline{3}, \overline{13}, \overline{23}$ (b) $\overline{3}, \overline{23}$

(c) $\overline{13}, \overline{23}$ (d) None of these

$\phi(\overline{23}) = \phi(\overline{20} + \overline{3}) = 9$

(a) $\Rightarrow \phi(\overline{20}) + \phi(\overline{3}) = 9$

$\Rightarrow \phi(\overline{3}) = 9$

$\left.\begin{array}{l} \phi(\overline{20}) = 0 \\ \phi(\overline{10}) = 0 \\ \phi(\overline{0}) = 0 \end{array}\right.$

$\phi(\overline{13}) = \phi(\overline{10} + \overline{3}) = \phi(10) + \phi(\overline{3}) = 9$

(6) Let G be a subgroup of some dihedral group. Define $\varphi: G \to \{1, -1\}$

$\varphi(x) = \begin{cases} 1 \text{ if x is a rotation} \\ -1 \text{ if x is a reflection} \end{cases}$ then $ker\varphi =$

(a) A subgroup containing only reflections.

(b) A subgroup containing only reflections and rotations.

(c) A subgroup containing only rotations.

(d) None of these

$\ker \phi = \{x \in G \mid \phi(x) = 1\}$

(c)

(7) How many homomorphisms are there from $\mathbb{Z}_{20}$ onto $\mathbb{Z}_{10}$?

(a) 4

(b) 5

(c) 10

(d) None of these

$(20, 10) = 10$

(c)

(8) Which of the following statements is true.

(a) $(\mathbb{Z}_4, +)$ and V_4(Klein's 4 group) are isomorphic.

(b) $(\mathbb{Z}_4, +)$and μ_4 (The group of fourth roots of unity) are isomorphic.

(c) $V_4$and $\mu_4$are isomorphic

(d) None of these

$(\mathbb{Z}_4, +)$ is cyclic group of order 4

(b) $(\mu_4, \cdot)$ is cyclic group of order 4

$\mathbb{Z}_4 \cong \mu_4$

(9) Let Q_8 be quaternion group $\{\pm 1, \pm i, \pm j, \pm k\}$ *where* $i^2 = j^2 = -1, ij = k = -ji$.
Consider the map $\varphi: Q_8 \to \mathbb{Z}_2$ defined by $\varphi(i) = \bar{0}, \varphi(j) = \bar{1}$ then

(a) φ is not a group homomorphism

(b) φ is a group homomorphism and $ker\varphi = \{1, i\}$

(c) φ is a group homomorphism and $ker\varphi = \{-i, i\}$

(d) None of these

(d) None of these

$i.j = k \Rightarrow \phi(i.j) = \phi(k)$

$\Rightarrow \phi(i).\phi(j) = \phi(k)$

$\Rightarrow \bar{0} \times \bar{1} = \phi(k)$

$\Rightarrow \phi(k) = \bar{0}$

(10) Suppose for each prime p, $\mathbb{Z}_p$ is the homomorphic image of a group G. What can we say about $|G|$?

(a) finite

(b) infinite

(c) prime

(d) None of these

$|Z_p| = p$, p is a prime.

$\frac{O(G)}{O(Z_p)}$ (c) prime.

(11) Let G be an abelian group which has no element of order 2 and $\varphi: G \to G$ given by $\varphi(x) = x^2$, then

(a) φ is an automorphism of G.

(b) φ is a group homomorphism which may not be one-one.

(c) φ is an automorphism of G if G is finite.

(d) φ is not a group homomorphism.

(a) $\phi(x) = x^2$, $\phi(y) = y^2$, $x, y \in G$

G is abelian

$\phi(xy) = (xy)^2 = x^2y^2 = \phi(x)\phi(y)$

$\ker\phi = \{x \in G \mid \phi(x) = e\}$

$x^2 = e$

But if $x \in G$ & $x \neq e$ then $x^2 = e$ not true

$\ker\phi = \{e\}$

(12) Let $\varphi: \mathbb{Z}_{12} \to Z_{10}$ given by $\varphi(x) = 3x$

(a) φ is not a group homomorphism

(b) φ is a group homomorphism which is not one-one

(c) φ is a group homomorphism which is not onto

(d) None of these

$\phi(x) = 3x, \quad \phi(y) = 3y$

$\phi(xy) = 3xy \neq (3x)(3y)$

$\therefore \quad \phi(xy) \neq \phi(x)\,\phi(y)$

(a)

(13) Consider the group G, where $G = \left\{\begin{pmatrix} a & a \\ a & a \end{pmatrix} : a \in \mathbb{R}\ , a \neq 0\right\}$ under multiplication of 2x2 matrices. then

(a) G is isomorphic to $(\mathbb{R}, +)$.

(b) G is isomorphic to $(\mathbb{R}^*, +)$

(c) G is isomorphic to $(SL_2(\mathbb{R}), +)$

(d) None of these

$G \to R, \quad f\begin{pmatrix} a & a \\ a & a \end{pmatrix} = a$

(b) as $a \neq 0$ for $\begin{pmatrix} a & a \\ a & a \end{pmatrix} \in G \Rightarrow f$ is not isomo

$G \to R^*, \quad f\begin{pmatrix} a & a \\ a & a \end{pmatrix} = a$

will satisfy all the property

$SL_2(R)$ = all 2x2 non singular matrix

(14) Let U(16) denote the group of prime residue classes modulo 16 under multiplication. Which of the following statements are false?

(a) $\varphi_1: U(16) \to U(16)$defined by $\varphi_1(x) = x^3$ is a group automorphism.

(b) $\varphi_2: U(16) \to U(16)$defined by $\varphi_2(x) = x^5$ is a group automorphism.

(c) $\varphi_3: U(16) \to U(16)$defined by $\varphi_3(x) = x^9$ is a group automorphism.

(d) $\varphi_4: U(16) \to U(16)$defined by $\varphi_1(x) = x^4$ is a group automorphism.

$U(16) = \{1, 3, 5, 7, 9, 11, 13, 15\}$

$\phi_1(3) = 3^3 = 27 \equiv 11 \pmod{16}$

$\phi_1(3) = 3^3 = 27 \equiv 11 \pmod{16}$

$\phi_1(5) = 5^3 = 125 \equiv 13 \pmod{16}$

$\phi(3 \times 5) = 11 \times 13 = 143 \equiv 15 \pmod{16}$

(15) Let m and n be integers. Then

(a) The groups $(m\mathbb{Z}, +)$ and $(n\mathbb{Z}, +)$ are isomorphic.

(b) The groups $(m\mathbb{Z}, +)$ and $(n\mathbb{Z}, +)$ are isomorphic if and only if $m = -n$.

(c) The groups $(m\mathbb{Z}, +)$ and $(n\mathbb{Z}, +)$ are not isomorphic if $m \neq n$.

(d) The groups $(m\mathbb{Z}, +)$ and $(n\mathbb{Z}, +)$ are isomorphic for all non-zero integers m and n.

(c)

(16) The map $f: GL_2(\mathbb{R}) \to GL_2(\mathbb{R})$ defined by $f(A) = (A^t)^{-1}$ is

(a) not a group homomorphism.

(b) group homomorphism and $kerf = SL_2(\mathbb{R})$.

(c) group homomorphism and $kerf = O_2(\mathbb{R})$.

(d) a group automorphism

$f(A) = (A^t)^{-1}, \quad f(B) = (B^t)^{-1}$

$f(AB) = ((AB)^t)^{-1} = (B^t A^t)^{-1} = (A^t)^{-1}(B^t)^{-1}$

$= f(A) \cdot f(B)$

$\ker f = \left\{ A \in GL_2(\mathbb{R}),\ f(A) = \begin{pmatrix} 1 & 0 \\ 0 & 1 \end{pmatrix} \right\}$

$(A^t)^{-1} = \begin{pmatrix} 1 & 0 \\ 0 & 1 \end{pmatrix}$

$A^t = \begin{pmatrix} 1 & 0 \\ 0 & 1 \end{pmatrix}$

$A = \begin{pmatrix} a & b \\ c & d \end{pmatrix}, \quad A^t = \begin{pmatrix} a & c \\ b & d \end{pmatrix} = \begin{pmatrix} 1 & 0 \\ 0 & 1 \end{pmatrix}$

$c = 0,\ b = 0,\ a = d = 1$

$\ker f = \left\{ \begin{pmatrix} 1 & 0 \\ 0 & 1 \end{pmatrix} \right\}$ hence f is 1-1

Similarly f is onto $\Big\} \Rightarrow (d)$

$\therefore f$ is an automorphism.

(17) The number of group homomorphism from S_3 *to* $(\mathbb{Z}_3, +)$ is

(a) 1 (b) 0

(17) The number of group homomorphism from S_3 to $(\mathbb{Z}_3, +)$ is

(a) 1 (b) 0

(c) 3 (d) 2

The only homomorphism from S_3 to Z_3 is the trivial homomorphism. given as

$f(g) = 0$ for any $g \in S_3$

Hence only one such homomorphism exists

(b)

(18) The number of group automorphism of V_4 (Klien's four group) is

(a) 4 (b) 2

(c) 3 (d) 6

$f : V_4 \to V_4$, $V_4 = \{e, a, b, c\}$

Identity ① $f(x) = x$ $\quad a^2 = b^2 = c^2 = e$

② $f(x) = x^2 \Rightarrow f(a) = a^2 = e$

$\Rightarrow f(b) = b^2 = e$

$f(c) = c^2 = e$

$f(a \times b) = f(c) = c^2 = e = e.e = f(a)f(b)$

(19) Let G be an abelian group of order n. The map $\varphi: G \to G$ given by $\varphi(x) = x^m$ where m is a positive integer is

(a) a group homomorphism if and only if m,n are relatively prime.

(b) a group homomorphism and $kerf = \{x \in G : x^d = e\}$ where $d = gdc(m, n)$

(c) a group homomorphism and ker f has order m.

(d) None of these.

(a)

(20) The number of onto homomorphisms from S_3 to V_4 are

(a) 1 (b) 0

(c) 2 ✓(d) 3

$S_3 = \{ I, (12), (13), (23), (123), (132) \}$

$o(12) = 2, \quad o(13) = 2, \quad o(23) = 2$

$a = (12), \ b = (13), \ c = (23)$

$\phi : S_3 \to V_4$

$\phi(a) = (12), \quad \phi(b) = (13), \quad \phi(c) = (23)$